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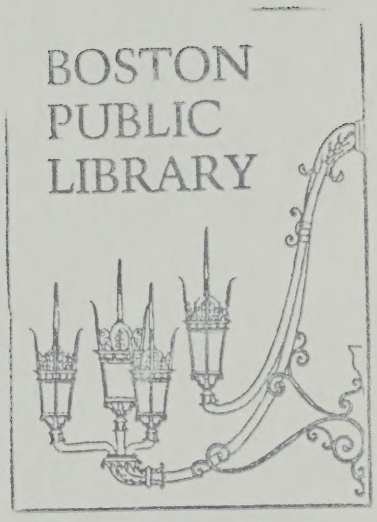

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APPENDIX - VOLUME I

Worcester Commuter Rail Extension Project

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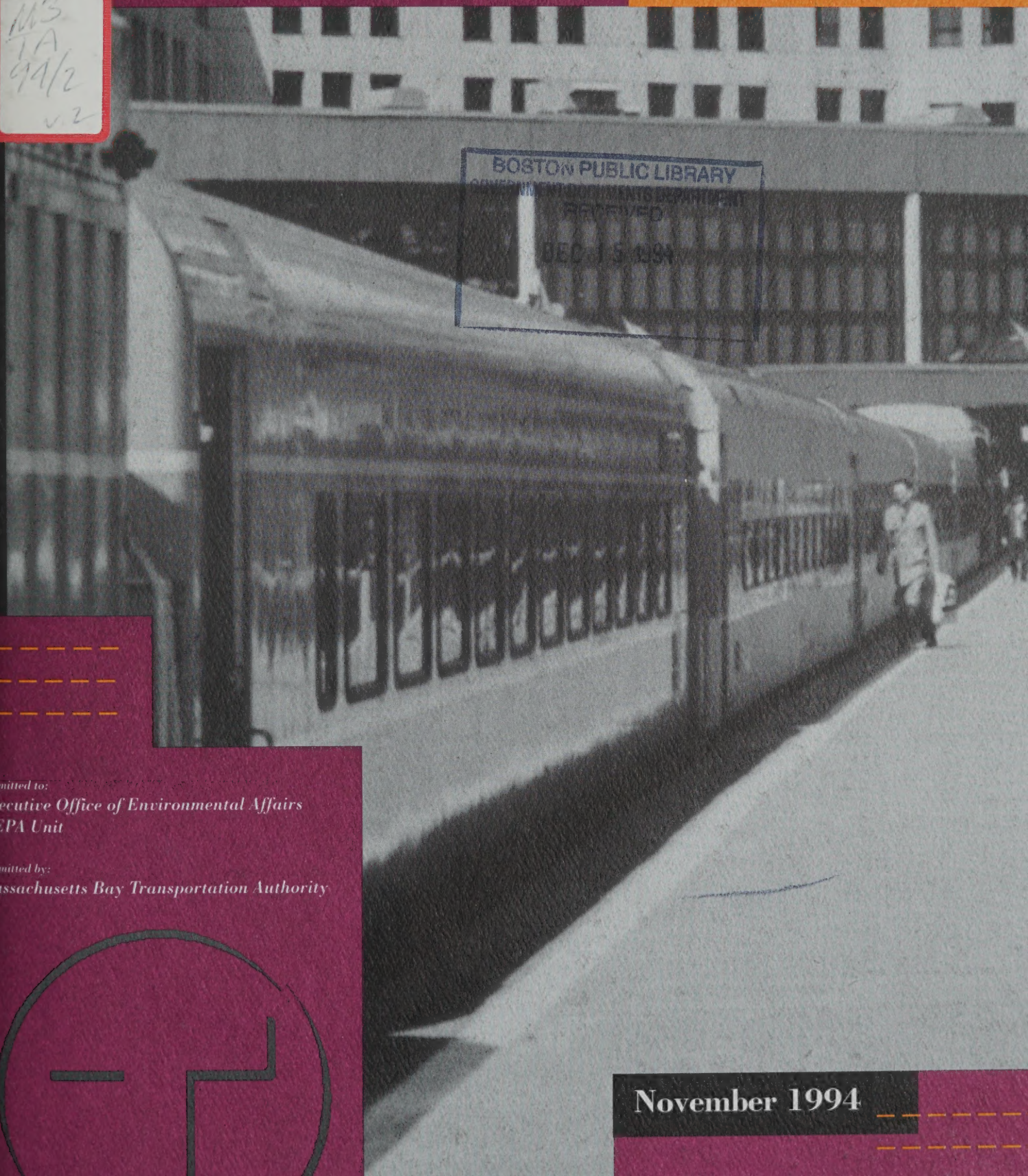

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SECTION 1.0

TRAFFIC ANALYSES

TABLE OF CONTENTS

APPENDICES

SECTION 1.0 TRAFFIC ANALYSIS

1.1 Analysis Methodology 1-1
Level of Service - General Description 1-1
Level of Service for Signalized Intersections 1-1
Level of Service for Unsignalized Intersections . . . 1-3
Level of Service for Roadway Segments 1-4
Capacity Adjustment for Railroad Gate Closings 1-4
Background Traffic Growth 1-5
Station Ridership - Trip Generation 1-6
Ridership Per Train 1-14
Vehicle Trip Generation 1-16
Roadway Systems 1-19
Limited Access Highways 1-20
Major Divided State Highways 1-20
Undivided State Highways 1-20
Arterial Roadways 1-20
Collector Streets 1-20
Subcollector Streets 1-21
Local Streets 1-21
Minor Streets 1-21
1.2 Worcester Station 1-22
Project Introduction 1-22
Study Area 1-22
Data Collection 1-22
Year 1992 Existing Conditions 1-23
Year 1996 Conditions 1-27
Year 1996 "No Build" Traffic Volumes 1-27
Year 1996 Trip Generation/Parking 1-28
Year 1996 Trip Distribution and Assignment 1-31
Year 1996 "Build" Traffic Volumes 1-33
Year 1996 Peak Hour Level of Service 1-33
Year 1996 "Ten Percent of Traffic" Analysis 1-37
Year 1996 Worcester Station Only 1-38
Year 2001 Conditions 1-38

Year 2001 "No Build" Traffic Volumes 1-38
Year 2001 Trip Generation/Parking 1-39
Year 2001 Trip Distribution and Assignment 1-42
Year 2001 "Build" Traffic Volumes 1-44
Year 2001 Peak Hour Level of Service Analysis 1-44
Year 2001 "Ten Percent of Traffic" Analysis 1-48
Summary of Findings 1-49
1.3 Millbury Station Route 122 Access Station 1-50
Project Introduction 1-50
Study Area 1-50
Data Collection 1-51
Year 1992 Existing Conditions 1-56
Year 1996 Conditions 1-63
Year 1996 "No Build" Traffic Volumes 1-63
Year 1996 Trip Generation And Parking 1-68
Year 1996 Trip Distribution and Assignment 1-69
Year 1996 "Build" Traffic Volumes 1-72
Year 1996 Peak Hour Level of Service 1-72
Year 1996 Peak Generator Hour Level Of Service 1-80
Year 1996 "Ten Percent of Traffic" Analysis 1-83
Year 1996 Millbury Station Only 1-84
Year 1996 Trip Generation/Parking (Millbury Station Only) 1-84
Year 1996 Trip Distribution and Assignment (Millbury Station Only) 1-85
Year 1996 "Build" Traffic Volumes (Millbury Station Only) 1-87
Year 1996 Peak Hour Level of Service (Millbury Station Only) 1-87
Year 1996 Peak Generator Hour Level of Service (Millbury Station Only) 1-96
Year 1996 "Ten Percent of Traffic" Analysis (Millbury Station Only) 1-99
Year 2001 Conditions 1-100
Year 2001 "No Build" Traffic Volumes 1-100
Year 2001 Trip Generation and Parking 1-101
Year 2001 Trip Distribution and Assignment 1-106
Year 2001 "Build" Traffic Volumes 1-108
Year 2001 Peak Hour Level of Service 1-114
Year 2001 Peak Generator Hour Level Of Service 1-117
Year 2001 "Ten Percent of Traffic" Analysis 1-121
Summary of Findings 1-122

1.4 Millbury Station Route 20 Access Station 1-124
Project Introduction 1-124
Study Area 1-124
Data Collection 1-125
Year 1992 Existing Conditions 1-130
Year 1996 Conditions 1-137
Year 1996 "No Build" Traffic Volumes 1-137
Proposed Traffic Control Change 1-138
Year 1996 Trip Generation And Parking 1-138
Year 1996 Trip Distribution and Assignment 1-143
Year 1996 "Build" Traffic Volumes 1-145
Year 1996 Peak Hour Level of Service 1-151
Year 1996 Peak Generator Hour Level Of Service 1-155
Year 1996 "Ten Percent of Traffic" Analysis 1-158
Year 1996 Millbury Station Only 1-159
Year 1996 Trip Generation/Parking (Millbury Station Only) 1-160
Year 1996 Trip Distribution and Assignment (Millbury Station Only) 1-160
Year 1996 "Build" Traffic Volumes (Millbury Station Only) 1-162
Year 1996 Peak Hour Level of Service (Millbury Station Only) 1-162
Unsignalized Intersections 1-169
Roadway Segments 1-170
Year 1996 Peak Generator Hour Level of Service (Millbury Station Only) 1-171
Year 1996 "Ten Percent of Traffic" Analysis 1-174
Year 2001 Conditions 1-175
Year 2001 "No Build" Traffic Volumes 1-176
Year 2001 Trip Generation and Parking 1-176
Year 2001 Trip Distribution and Assignment 1-181
Year 2001 "Build" Traffic Volumes 1-183
Year 2001 Peak Hour Level of Service 1-185
Year 2001 Peak Generator Hour Level Of Service 1-193
Year 2001 "Ten Percent of Traffic" Analysis 1-196
Summary of Findings 1-197

1.5 Grafton Station 1-199
Project Introduction 1-199
Study Area 1-199
Data Collection 1-200
Year 1992 Existing Conditions 1-205
Year 1996 Conditions 1-210
Year 1996 "No Build" Traffic Volumes 1-210
Year 1996 Trip Generation/Parking 1-211
Year 1996 Trip Distribution and Assignment 1-216
Year 1996 "Build" Traffic Volumes 1-218
Year 1996 Peak Hour Level of Service 1-218
Year 1996 Peak Generator Hour Level of Service 1-226
Year 1996 "Ten Percent of Traffic" Analysis 1-228
Year 1996 Grafton Station Only 1-229
Year 1996 Trip Generation/Parking (Grafton Station Only) 1-229
Year 1996 Trip Distribution and Assignment (Grafton Station Only) 1-230
Year 1996 "Build" Traffic Volumes (Grafton Station Only) 1-232
Year 1996 Peak Hour Level of Service (Grafton Station Only) 1-232
Year 1996 Peak Generator Hour Level of Service (Grafton Station Only) 1-240
Year 1996 "Ten Percent of Traffic" Analysis (Grafton Station Only) 1-242
Year 2001 Conditions 1-243
Year 2001 "No Build" Traffic Volumes 1-243
Year 2001 Trip Generation/Parking 1-244
Year 2001 Trip Distribution and Assignment 1-244
Year 2001 "Build" Traffic Volumes 1-249
Year 2001 Peak Hour Level of Service 1-255
Year 2001 Peak Generator Hour Level of Service 1-257
Year 2001 "Ten Percent of Traffic" Analysis 1-259
Summary of Findings 1-260

1.6 Westborough Station 1-261
Project Introduction 1-261
Study Area 1-261
Data Collection 1-262
Year 1992 Existing Conditions 1-265
Year 1996 Conditions 1-273
Year 1996 "No Build" Traffic Volumes 1-273
Year 1996 Trip Generation/Parking 1-274
Year 1996 Distribution and Assignment 1-279
Year 1996 "Build" Traffic Volumes 1-281
Year 1996 Peak Hour Level of Service 1-281
Year 1996 Peak Generator Hour Level of Service 1-289
Year 1996 "Ten Percent of Traffic" Analysis 1-292
Year 1996 Westborough Station Only 1-293
Year 1996 Trip Generation/Parking (Westborough Station Only) 1-293
Year 1996 Trip Distribution and Assignment (Westborough Station Only) 1-294
Year 1996 "Build" Traffic Volumes (Westborough Station Only) 1-296
Year 1996 Peak Hour Level of Service (Westborough Station Only) 1-296
Year 1996 Peak Generator Hour Level of Service (Westborough Station Only) 1-304
Unsignalized Intersections 1-305
Year 1996 "Ten Percent of Traffic" Analysis (Westborough Station Only) 1-307
Year 2001 Conditions 1-308
Year 2001 "No Build" Traffic Volumes 1-308
Year 2001 Trip Generation/Parking 1-309
Year 2001 Trip Distribution and Assignment 1-314
Year 2001 "Build" Traffic Volumes 1-315
Year 2001 Peak Hour Level of Service 1-315
Year 2001 Peak Generator Hour Level of Service 1-323
Year 2001 "Ten Percent of Traffic" Analysis 1-325
Fountainhead Plaza 1-326
Summary of Findings 1-330

1.7 Southborough Station 1-331
Project Introduction 1-331
Study Area 1-331
Data Collection 1-332
Year 1992 Existing Conditions 1-333
Year 1996 Conditions 1-344
Year 1996 "No Build" Traffic Volumes 1-344
Year 1996 Trip Generation/Parking 1-345
Year 1996 Trip Distribution and Assignment 1-350
Year 1996 "Build" Traffic Volumes 1-353
Year 1996 Peak Hour Level of Service 1-353
Year 1996 Peak Generator Hour Level of Service 1-361
Year 1996 "Ten Percent of Traffic" Analysis 1-364
Year 1996 Southborough Station Only 1-365
Year 1996 Trip Generation/Parking (Southborough Station Only) 1-365
Year 1996 Trip Distribution and Assignment (Southborough Station Only) 1-366
Year 1996 "Build" Traffic Volumes (Southborough Station Only) 1-368
Year 1996 Peak Hour Level of Service (Southborough Station Only) 1-370
Year 1996 Peak Generator Hour Level of Service (Southborough Station Only) 1-377
Year 1996 "Ten Percent of Traffic" Analysis (Southborough Station Only) 1-380
Year 2001 Conditions 1-381
Year 2001 "No Build" Traffic Volumes 1-381
Year 2001 Trip Generation/Parking 1-384
Year 2001 Trip Distribution and Assignment 1-387
Year 2001 "Build" Traffic Volumes 1-388
Year 2001 Peak Hour Level of Service 1-388
Year 2001 Peak Generator Hour Level of Service 1-397
Year 2001 "Ten Percent of Traffic" Analysis 1-400
Construction Impacts of Replacing Railroad Bridge 1-401
Summary of Findings 1-401

1.8 Ashland Station-East 1-403
Project Introduction 1-403
Study Area 1-403
Data Collection 1-404
Year 1992 Existing Conditions 1-405
Safety Concerns and Accident History 1-417
Year 1996 Conditions 1-418
Year 1996 "No Build" Traffic Volumes 1-418
Year 1996 Trip Generation/Parking 1-419
Year 1996 Trip Distribution and Assignment 1-424
Year 1996 "Build" Traffic Volumes 1-426
Year 1996 Peak Hour Level of Service 1-432
Year 1996 Peak Generator Hour Level of Service 1-437
Year 1996 "Ten Percent of Traffic" Analysis 1-442
Year 1996 Ashland Station Only 1-443
Year 1996 Trip Generation/Parking (Ashland Station Only) 1-443
Year 1996 Trip Distribution and Assignment (Ashland Station Only) 1-444
Year 1996 "Build" Traffic Volumes (Ashland Station Only) 1-446
Year 1996 Peak Hour Levels of Service (Ashland Station Only) 1-446
Year 1996 Peak Generator Hour Level of Service (Ashland Station Only) 1-456
Year 1996 Ten Percent of Traffic Analysis (Ashland Station Only) 1-461
Year 2001 Conditions 1-462
Year 2001 "No Build" Traffic Volumes 1-462
Year 2001 Trip Generation/Parking 1-465
Year 2001 Trip Distribution and Assignment 1-468
Year 2001 "Build" Traffic Volumes 1-469
Year 2001 Peak Hour Level of Service 1-469
Year 2001 Peak Generator Hour Level of Service 1-479
Year 2001 "Ten Percent of Traffic" Analysis 1-483
Summary of Findings 1-484

1.9 Ashland Station-West 1-486
Project Introduction 1-486
Study Area 1-486
Data Collection 1-487
Year 1992 Existing Conditions 1-488
Safety Concerns and Accident History 1-500
Year 1996 Conditions 1-501
Year 1996 "No Build" Traffic Volumes 1-501
Year 1996 Trip Generation/Parking 1-504
Year 1996 Trip Distribution and Assignment 1-507
Year 1996 "Build" Traffic Volumes 1-509
Year 1996 Peak Hour Level of Service 1-515
Year 1996 Peak Generator Hour Level of Service 1-520
Year 1996 "Ten Percent of Traffic" Analysis 1-523
Year 1996 Ashland Station Only 1-524
Year 1996 Trip Generation/Parking (Ashland Station Only) 1-525
Year 1996 Trip Distribution and Assignment (Ashland Station Only) 1-526
Year 1996 "Build" Traffic Volumes (Ashland Station Only) 1-528
Year 1996 Peak Hour Levels of Service (Ashland Station Only) 1-528
Year 1996 Peak Generator Hour Level of Service (Ashland Station Only) 1-538
Year 1996 Ten Percent of Traffic Analysis (Ashland Station Only) 1-542
Year 2001 Conditions 1-543
Year 2001 "No Build" Traffic Volumes 1-543
Year 2001 Trip Generation/Parking 1-543
Year 2001 Trip Distribution and Assignment 1-548
Year 2001 "Build" Traffic Volumes 1-551
Year 2001 Peak Hour Level of Service 1-551
Year 2001 Peak Generator Hour Level of Service 1-559
Year 2001 "Ten Percent of Traffic" Analysis 1-563
Summary of Findings 1-564

LIST OF FIGURES

Figure 1.2-1 A.M. Peak Hour 7:30 - 8:30 A.M. 1992 Existing Conditions INTERIM STATION, Worcester 1-24

Figure 1.2-2 P.M. Peak Hour 4:30 - 5:30 P.M. 1992 Existing Conditions INTERIM STATION, Worcester 1-25

Figure 1.2-3 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 NO BUILD INTERIM STATION, Worcester 1-29

Figure 1.2-4 P.M. Peak Hour 4:30 - 5:30 P.M. 1996 NO BUILD INTERIM STATION, Worcester 1-30

Figure 1.2-5 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS INTERIM STATION, Worcester 1-34

Figure 1.2-6 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD ALL STATIONS INTERIM STATION, Worcester 1-35

Figure 1.2-7 P.M. Peak Hour 4:30 - 5:30 P.M. 1996 BUILD ALL STATIONS INTERIM STATION, Worcester 1-36

Figure 1.2-8 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 NO BUILD INTERIM STATION, Worcester 1-40

Figure 1.2-9 P.M. Peak Hour 4:30 - 5:30 P.M. 2001 NO BUILD INTERIM STATION, Worcester 1-41

Figure 1.2-10 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS INTERIM STATION, Worcester 1-45

Figure 1.2-11 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 BUILD ALL STATIONS INTERIM STATION, Worcester 1-46

Figure 1.2-12 P.M. Peak Hour 4:30 - 5:30 P.M. 2001 BUILD ALL STATIONS INTERIM STATION, Worcester 1-47

Figure 1.3-1 A.M. Peak Hour 7:15 - 8:15 A.M. 1992 Existing Conditions MILLBURY STATION - Route 122 1-52

Figure 1.3-2 P.M. Peak Hour 5:00 - 6:00 P.M. 1992 Existing Conditions MILLBURY STATION - Route 122 1-53

Figure 1.3-3 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1992 Existing Conditions MILLBURY STATION - Route 122 1-54

Figure 1.3-4 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1992 Existing Conditions MILLBURY STATION - Route 122 1-55

Figure 1.3-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic - MILLBURY, MA - Route 122 1-62

Figure 1.3-6 A.M. Peak Hour 7:15 - 8:15 A.M. 1996 NO BUILD MILLBURY STATION - Route 122 1-64

Figure 1.3-7 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 NO BUILD MILLBURY STATION - Route 122 1-65

Figure 1.3-8 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 NO BUILD MILLBURY STATION - Route 122 1-66

Figure 1.3-9 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1996 NO BUILD MILLBURY STATION - Route 122 1-67

Figure 1.3-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-71

Figure 1.3-11 A.M. Peak Hour 7:15 - 8:15 A.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-73

Figure 1.3-12 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-74

Figure 1.3-13 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-75

Figure 1.3-14 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-76

Figure 1.3-15 Distribution of Commuter Rail Station Traffic 1996 BUILD Millbury Only MILLBURY STATION - Route 122 1-88

Figure 1.3-16 A.M. Peak Hour 7:15 - 8:15 A.M. 1996 BUILD Millbury Only MILLBURY STATION - Route 122 1-89

Figure 1.3-17 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 Build Millbury Only MILLBURY STATION - Route 122 1-90

Figure 1.3-18 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 Build Millbury Only MILLBURY STATION - Route 122 1-91

Figure 1.3-19 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1996 Build Millbury Only MILLBURY STATION - Route 122 1-92

Figure 1.3-20 A.M. Peak Hour 7:15 - 8:15 A.M. 2001 NO BUILD MILLBURY STATION - Route 122 1-102

Figure 1.3-21 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 NO BUILD MILLBURY STATION - Route 122 1-103

Figure 1.3-22 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 2001 NO BUILD MILLBURY STATION - Route 122 1-104

Figure 1.3-23 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 2001 NO BUILD MILLBURY STATION - Route 122 1-105

Figure 1.3-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-109

Figure 1.3-25 A.M. Peak Hour 7:15 - 8:15 A.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-110

Figure 1.3-26 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-111

Figure 1.3-27 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-112

Figure 1.3-28 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 122 1-113

Figure 1.4-1 A.M. Peak Hour 7:15 - 8:15 A.M. 1992 Existing Conditions MILLBURY STATION - Route 20 1-126

Figure 1.4-2 P.M. Peak Hour 5:00 - 6:00 P.M. 1992 Existing Conditions MILLBURY STATION - Route 20 1-127

Figure 1.4-3 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1992 Existing Conditions MILLBURY STATION - Route 20 1-128

Figure 1.4-4 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1992 Existing Conditions MILLBURY STATION - Route 20 1-129

Figure 1.4-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic MILLBURY, MA - Route 20 1-136

Figure 1.4-6 A.M. Peak Hour 7:15 - 8:15 A.M. 1996 NO BUILD MILLBURY STATION - Route 20 1-139

Figure 1.4-7 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 NO BUILD MILLBURY STATION - Route 20 1-140

Figure 1.4-8 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 NO BUILD MILLBURY STATION - Route 20 1-141

Figure 1.4-9 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1996 NO BUILD MILLBURY STATION - Route 20 1-142

Figure 1.4-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-146

Figure 1.4-11 A.M. Peak Hour 7:15 - 8:15 A.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-147

Figure 1.4-12 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-148

Figure 1.4-13 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-149

Figure 1.4-14 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1996 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-150

Figure 1.4-15 Distribution of Commuter Rail Station Traffic 1996 BUILD Millbury Only MILLBURY STATION - Route 20 1-163

Figure 1.4-16 A.M. Peak Hour 7:15 - 8:15 A.M. 1996 BUILD Millbury Only MILLBURY STATION - Route 20 1-164

Figure 1.4-17 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD Millbury Only MILLBURY STATION - Route 20 1-165

Figure 1.4-18 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 BUILD Millbury Only MILLBURY STATION - Route 20 1-166

Figure 1.4-19 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 1996 BUILD Millbury Only MILLBURY STATION - Route 20 1-167

Figure 1.4-20 A.M. Peak Hour 7:15 - 8:15 A.M. 2001 NO BUILD MILLBURY STATION - Route 20 1-177

Figure 1.4-21 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 NO BUILD MILLBURY STATION - Route 20 1-178

Figure 1.4-22 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 2001 NO BUILD MILLBURY STATION - Route 20 1-179

Figure 1.4-23 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 2001 NO BUILD MILLBURY STATION - Route 20 1-180

Figure 1.4-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-184

Figure 1.4-25 A.M. Peak Hour 7:15 - 8:15 A.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-186

Figure 1.4-26 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-187

Figure 1.4-27 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-188

Figure 1.4-28 P.M. Peak Generator Hour 6:00 - 7:00 P.M. 2001 BUILD ALL STATIONS MILLBURY STATION - Route 20 1-189

Figure 1.5-1 A.M. Peak Hour 7:30 - 8:30 A.M. 1992 Existing Conditions GRAFTON STATION 1-201

Figure 1.5-2 P.M. Peak Hour 4:45 - 5:45 P.M. 1992 Existing Conditions GRAFTON STATION 1-202

Figure 1.5-3 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1992 Existing Conditions GRAFTON STATION 1-203

Figure 1.5-4 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1992 Existing Conditions GRAFTON STATION 1-204

Figure 1.5-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic GRAFTON STATION 1-208

Figure 1.5-6 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 NO BUILD GRAFTON STATION 1-212

Figure 1.5-7 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 NO BUILD GRAFTON STATION 1-213

Figure 1.5-8 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 NO BUILD GRAFTON STATION 1-214

Figure 1.5-9 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1996 NO BUILD GRAFTON STATION 1-215

Figure 1.5-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS GRAFTON STATION 1-219

Figure 1.5-11 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD ALL STATIONS GRAFTON STATION 1-220

Figure 1.5-12 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 BUILD ALL STATIONS GRAFTON STATION 1-221

Figure 1.5-13 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 BUILD ALL STATIONS GRAFTON STATION 1-222

Figure 1.5-14 P.M. Peak Generator Hour 5:45 - 6:45 A.M. 1996 BUILD ALL STATIONS GRAFTON STATION 1-223

Figure 1.5-15 Distribution of Commuter Rail Station Traffic 1996 BUILD Grafton Only GRAFTON STATION 1-233

Figure 1.5-16 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD Grafton Only GRAFTON STATION 1-234

Figure 1.5-17 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 BUILD Grafton Only GRAFTON STATION 1-235

Figure 1.5-18 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 1996 BUILD Grafton Only GRAFTON STATION 1-236

Figure 1.5-19 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1996 BUILD Grafton Only GRAFTON STATION 1-237

Figure 1.5-20 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 NO BUILD GRAFTON STATION 1-245

Figure 1.5-21 P.M. Peak Hour 4:45 - 5:45 P.M. 2001 NO BUILD GRAFTON STATION 1-246

Figure 1.5-22 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 2001 NO BUILD GRAFTON STATION 1-247

Figure 1.5-23 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 2001 NO BUILD GRAFTON STATION 1-248

Figure 1.5-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS GRAFTON STATION 1-250

Figure 1.5-25 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 BUILD ALL STATIONS GRAFTON STATION 1-251

Figure 1.5-26 P.M. Peak Hour 4:45 - 5:45 P.M. 2001 BUILD ALL STATIONS GRAFTON STATION 1-252

Figure 1.5-27 A.M. Peak Generator Hour 6:45 - 7:45 A.M. 2001 BUILD ALL STATIONS GRAFTON STATION 1-253

Figure 1.5-28 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 2001 BUILD ALL STATIONS GRAFTON STATION 1-254

Figure 1.6-1 A.M. Peak Hour 7:30 - 8:30 A.M. 1992 Existing Conditions WESTBOROUGH STATION 1-263

Figure 1.6-2 P.M. Peak Hour 4:45 - 5:45 P.M. 1992 Existing Conditions WESTBOROUGH STATION 1-264

Figure 1.6-3 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1992 Existing Conditions - WESTBOROUGH STATION 1-266

Figure 1.6-4 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1992 Existing Conditions - WESTBOROUGH STATION 1-267

Figure 1.6-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic - Westborough, MA 1-272

Figure 1.6-6 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 NO BUILD - WESTBOROUGH STATION 1-275

Figure 1.6-7 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 NO BUILD - WESTBOROUGH STATION 1-276

Figure 1.6-8 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1996 NO BUILD - WESTBOROUGH STATION 1-277

Figure 1.6-9 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1996 NO BUILD - WESTBOROUGH STATION 1-278

Figure 1.6-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS - WESTBOROUGH STATION 1-282

Figure 1.6-11 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD ALL STATIONS - WESTBOROUGH STATION 1-283

Figure 1.6-12 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 BUILD ALL STATIONS - WESTBOROUGH STATION 1-284

Figure 1.6-13 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1996 BUILD ALL STATIONS - WESTBOROUGH STATION 1-285

Figure 1.6-14 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1996 BUILD ALL STATIONS - WESTBOROUGH STATION 1-286

Figure 1.6-15 Distribution of Commuter Rail Station Traffic 1996 BUILD - Westborough Only WESTBOROUGH STATION 1-297

Figure 1.6-16 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD Westborough Only WESTBOROUGH STATION 1-298

Figure 1.6-17 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 BUILD - Westborough Only WESTBOROUGH STATION 1-299

Figure 1.6-18 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1996 BUILD - Westborough Only WESTBOROUGH STATION 1-300

Figure 1.6-19 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 1996 BUILD - Westborough Only WESTBOROUGH STATION 1-301

Figure 1.6-20 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 NO BUILD - WESTBOROUGH STATION 1-310

Figure 1.6-21 P.M. Peak Hour 4:45 - 5:45 P.M. 2001 NO BUILD - WESTBOROUGH STATION 1-311

Figure 1.6-22 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 2001 NO BUILD" - WESTBOROUGH STATION 1-312

Figure 1.6-23 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 2001 NO BUILD - WESTBOROUGH STATION 1-313

Figure 1.6-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS WESTBOROUGH STATION 1-316

Figure 1.6-25 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 BUILD ALL STATIONS WESTBOROUGH STATION 1-317

Figure 1.6-26 P.M. Peak Hour 4:45 - 5:45 P.M. 2001 BUILD ALL STATIONS WESTBOROUGH STATION 1-318

Figure 1.6-27 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 2001 BUILD ALL STATIONS WESTBOROUGH STATION 1-319

Figure 1.6-28 P.M. Peak Generator Hour 5:45 - 6:45 P.M. 2001 BUILD ALL STATIONS WESTBOROUGH STATION 1-320

Figure 1.6-29 P.M. Peak Hour 4:45 - 5:45 P.M. - Fountainhead Plaza Option -2001 NO BUILD - WESTBOROUGH STATION 1-327

Figure 1.6-30 P.M. Peak Hour 4:45 - 5:45 P.M. - Fountainhead Plaza Option - 2001 BUILD WESTBOROUGH STATION 1-329

Figure 1.7-1 A.M. Peak Hour 7:30 - 8:30 A.M. 1992 Existing Conditions SOUTHBOROUGH STATION 1-334

Figure 1.7-2 P.M. Peak Hour 4:45 - 5:45 P.M. 1992 Existing Conditions SOUTHBOROUGH STATION 1-335

Figure 1.7-3 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1992 Existing Conditions SOUTHBOROUGH STATION 1-336

Figure 1.7-4 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1992 Existing Conditions SOUTHBOROUGH STATION 1-337

Figure 1.7-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic SOUTHBOROUGH, MA 1-342

Figure 1.7-6 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 NO BUILD SOUTHBOROUGH STATION 1-346

Figure 1.7-7 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 NO BUILD SOUTHBOROUGH STATION 1-347

Figure 1.7-8 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1996 NO BUILD SOUTHBOROUGH STATION 1-348

Figure 1.7-9 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 NO BUILD SOUTHBOROUGH STATION 1-349

Figure 1.7-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-352

Figure 1.7-11 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-355

Figure 1.7-12 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-356

Figure 1.7-13 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1996 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-357

Figure 1.7-14 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-358

Figure 1.7-15 Distribution of Commuter Rail Station Traffic 1996 BUILD Southborough Only SOUTHBOROUGH STATION 1-369

Figure 1.7-16 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD Southborough Only SOUTHBOROUGH STATION 1-371

Figure 1.7-17 P.M. Peak Hour 4:45 - 5:45 P.M. 1996 BUILD Southborough Only SOUTHBOROUGH STATION 1-372

Figure 1.7-18 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 1996 BUILD Southborough Only SOUTHBOROUGH STATION 1-373

Figure 1.7-19 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 BUILD Southborough Only SOUTHBOROUGH STATION 1-374

Figure 1.7-20 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 NO BUILD SOUTHBOROUGH STATION 1-382

Figure 1.7-21 P.M. Peak Hour 4:45 - 5:45 P.M. 2001 NO BUILD SOUTHBOROUGH STATION 1-383

Figure 1.7-22 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 2001 NO BUILD SOUTHBOROUGH STATION 1-385

Figure 1.7-23 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 2001 NO BUILD SOUTHBOROUGH STATION 1-386

Figure 1.7-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-389

Figure 1.7-25 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-390

Figure 1.7-26 P.M. Peak Hour 4:45 - 5:45 P.M. 2001 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-391

Figure 1.7-27 A.M. Peak Generator Hour 7:00 - 8:00 A.M. 2001 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-392

Figure 1.7-28 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 2001 BUILD ALL STATIONS SOUTHBOROUGH STATION 1-393

Figure 1.8-1 A.M. Peak Hour 7:30 - 8:30 A.M. 1992 Existing Conditions ASHLAND STATION-EAST 1-406

Figure 1.8-2 P.M. Peak Hour 5:00 - 6:00 P.M. 1992 Existing Conditions ASHLAND STATION-EAST 1-407

Figure 1.8-3 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1992 Existing Conditions ASHLAND STATION-EAST 1-408

Figure 1.8-4 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1992 Existing Conditions ASHLAND STATION-EAST 1-409

Figure 1.8-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic ASHLAND, MA 1-416

Figure 1.8-6 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 NO BUILD ASHLAND STATION-EAST 1-420

Figure 1.8-7 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 NO BUILD ASHLAND STATION-EAST 1-421

Figure 1.8-8 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1996 NO BUILD ASHLAND STATION-EAST 1-422

Figure 1.8-9 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 NO BUILD ASHLAND STATION-EAST 1-423

Figure 1.8-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS ASHLAND STATION-EAST 1-427

Figure 1.8-11 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD ALL STATIONS ASHLAND STATION-EAST 1-428

Figure 1.8-12 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD ALL STATIONS ASHLAND STATION-EAST 1-429

Figure 1.8-13 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1996 BUILD ALL STATIONS ASHLAND STATION-EAST 1-430

Figure 1.8-14 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 BUILD ALL STATIONS ASHLAND STATION-EAST 1-431

Figure 1.8-15 Distribution of Commuter Rail Station Traffic 1996 BUILD Ashland Only ASHLAND STATION-EAST 1-447

Figure 1.8-16 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD Ashland Only ASHLAND STATION-EAST 1-448

Figure 1.8-17 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD Ashland Only ASHLAND STATION-EAST 1-449

Figure 1.8-18 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1996 BUILD Ashland Only ASHLAND STATION-EAST 1-450

Figure 1.8-19 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 BUILD Ashland Only ASHLAND STATION-EAST 1-451

Figure 1.8-20 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 NO BUILD ASHLAND STATION-EAST 1-463

Figure 1.8-21 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 NO BUILD ASHLAND STATION-EAST 1-464

Figure 1.8-22 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 2001 NO BUILD ASHLAND STATION-EAST 1-466

Figure 1.8-23 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 2001 NO BUILD ASHLAND STATION-EAST 1-467

Figure 1.8-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS ASHLAND STATION-EAST 1-470

Figure 1.8-25 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 BUILD ALL STATIONS ASHLAND STATION-EAST 1-471

Figure 1.8-26 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 BUILD ALL STATIONS ASHLAND STATION-EAST 1-472

Figure 1.8-27 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 2001 BUILD ALL STATIONS ASHLAND STATION-EAST 1-473

Figure 1.8-28 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 2001 BUILD ALL STATIONS ASHLAND STATION-EAST 1-474

Figure 1.9-1 A.M. Peak Hour 7:30 - 8:30 A.M. 1992 Existing Conditions ASHLAND STATION-WEST 1-489

Figure 1.9-2 P.M. Peak Hour 5:00 - 6:00 P.M. 1992 Existing Conditions ASHLAND STATION-WEST 1-490

Figure 1.9-3 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1992 Existing Conditions ASHLAND STATION-WEST 1-491

Figure 1.9-4 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1992 Existing Conditions ASHLAND STATION-WEST 1-492

Figure 1.9-5 1992 Average Daily Traffic and 1992 Average Weekday Traffic ASHLAND, MA 1-499

Figure 1.9-6 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 NO BUILD ASHLAND STATION-WEST 1-502

Figure 1.9-7 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 NO BUILD ASHLAND STATION-WEST 1-503

Figure 1.9-8 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1996 NO BUILD ASHLAND STATION-WEST 1-505

Figure 1.9-9 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 NO BUILD ASHLAND STATION-WEST 1-506

Figure 1.9-10 Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS ASHLAND STATION-WEST 1-510

Figure 1.9-11 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD ALL STATIONS ASHLAND STATION-WEST 1-511

Figure 1.9-12 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD ALL STATIONS ASHLAND STATION-WEST 1-512

Figure 1.9-13 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1996 BUILD ALL STATIONS ASHLAND STATION-WEST 1-513

Figure 1.9-14 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 BUILD ALL STATIONS ASHLAND STATION-WEST 1-514

Figure 1.9-15 Distribution of Commuter Rail Station Traffic 1996 BUILD Ashland Only ASHLAND STATION-WEST 1-529

Figure 1.9-16 A.M. Peak Hour 7:30 - 8:30 A.M. 1996 BUILD Ashland Only ASHLAND STATION-WEST 1-530

Figure 1.9-17 P.M. Peak Hour 5:00 - 6:00 P.M. 1996 BUILD Ashland Only ASHLAND STATION-WEST 1-531

Figure 1.9-18 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 1996 BUILD Ashland Only ASHLAND STATION-WEST 1-532

Figure 1.9-19 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 1996 BUILD Ashland Only ASHLAND STATION-WEST 1-533

Figure 1.9-20 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 NO BUILD ASHLAND STATION-WEST 1-544

Figure 1.9-21 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 NO BUILD ASHLAND STATION-WEST 1-545

Figure 1.9-22 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 2001 NO BUILD ASHLAND STATION-WEST 1-546

Figure 1.9-23 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 2001 NO BUILD ASHLAND STATION-WEST 1-547

Figure 1.9-24 Distribution of Commuter Rail Station Traffic 2001 BUILD ALL STATIONS ASHLAND STATION-WEST 1-550

Figure 1.9-25 A.M. Peak Hour 7:30 - 8:30 A.M. 2001 BUILD ALL STATIONS ASHLAND STATION-WEST 1-552

Figure 1.9-26 P.M. Peak Hour 5:00 - 6:00 P.M. 2001 BUILD ALL STATIONS ASHLAND STATION-WEST 1-553

Figure 1.9-27 A.M. Peak Generator Hour 7:15 - 8:15 A.M. 2001 BUILD ALL STATIONS ASHLAND STATION-WEST 1-554

Figure 1.9-28 P.M. Peak Generator Hour 5:30 - 6:30 P.M. 2001
BUILD ALL STATIONS ASHLAND
STATION-WEST 1-555

LIST OF TABLES

Table 1.1-1 Level of Service for Unsignalized Intersections 1-3

Table 1.1-2 Expected Ridership Without A Regional Station 1-7

Table 1.1-3 Expected Ridership with a Regional Station 1-9

Table 1.1-4 Expected Ridership of 1996 Single Station Only Analysis 1-11

Table 1.1-5 Percentage of Passengers 1-16

Table 1.1-6 Year 1996 Vehicle Trips Generated 1-17

Table 1.1-7 Year 2001 Vehicle Trips Generated 1-18

Table 1.2-1 1992 Unsignalized Intersection Level of Service 1-26

Table 1.2-2 Projected Patrons of Worcester Station - Year 1996 1-31

Table 1.2-3 MBTA Ridership Distribution 1-32

Table 1.2-4 1996 Peak Hour Unsignalized Intersection Level of Service 1-37

Table 1.2-5 1996 "Build" Condition Percentage of Site Traffic 1-38

Table 1.2-6 Projected Patrons of Worcester Station - Year 2001 1-42

Table 1.2-7 MBTA Ridership Distribution Year 2001 1-43

Table 1.2-8 2001 Peak Hour Unsignalized Intersection Level of Service 1-48

Table 1.2-9 2001 "Build" Condition Percentage of Traffic 1-49

Table 1.3-1 1992 Existing Signalized Intersection Level of Service 1-57

Table 1.3-2 1992 Unsignalized Intersection Level of Service 1-60

Table 1.3-3 1992 Existing Road Segment Level of Service 1-61

Table 1.3-4 Projected Patrons of Millbury Station - Year 1996 1-68

Table 1.3-5 MBTA Ridership Distribution 1-69

Table 1.3-6 1996 Peak Hour Signalized Intersection Level of Service 1-78

Table 1.3-7 1996 Peak Hour Unsignalized Intersection Level of Service 1-78

Table 1.3-8 1996 Peak Hour Road Segment Level of Service 1-80

Table 1.3-9 1996 Peak Generator Hour Signalized Intersection Level of Service 1-80

Table 1.3-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-81

Table 1.3-11 1996 Peak Generator Hour Road Segment Level of Service 1-83

Table 1.3-12 1996 "Build" Condition - 10% Analysis 1-84

Table 1.3-13 Projected Patrons of Millbury Station Only Year 1996 1-85

Table 1.3-14 MBTA Ridership Distribution (Millbury Station Only) 1-86

Table 1.3-15 1996 Peak Hour Signalized Intersection Level of Service (Millbury Station Only) 1-93

Table 1.3-16 1996 Peak Hour Unsignalized Intersection Level of Service (Millbury Station Only) 1-95

Table 1.3-17 1996 Peak Hour Road Segment Level of Service (Millbury Station Only) 1-96

Table 1.3-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Millbury Station Only) 1-97

Table 1.3-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Millbury Station Only) 1-98

Table 1.3-20 1996 Peak Generator Hour Segment Level of Service (Millbury Station Only) 1-99

Table 1.3-21 1996 "Build" Condition - 10% Analysis (Millbury Station Only) 1-100

Table 1.3-22 Projected Patrons of Millbury Station - Year 2001 1-106

Table 1.3-23 MBTA Ridership Distribution 1-107

Table 1.3-24 2001 Peak Hour Signalized Intersection Level of Service 1-114

Table 1.3-25 2001 Peak Hour Unsignalized Intersection Level of Service 1-116

Table 1.3-26 2001 Peak Hour Road Segment Level of Service 1-117

Table 1.3-27 2001 Peak Generator Hour Signalized Intersection Level of Service 1-118

Table 1.3-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-120

Table 1.3-29 2001 Peak Generator Hour Road Segment Level of Service 1-121

Table 1.3-30 2001 "Build" Condition - 10% Analysis 1-122

Table 1.4-1 1992 Existing Signalized Intersection Level of Service 1-131

Table 1.4-2 1992 Unsignalized Intersection Level of Service 1-134

Table 1.4-3 1992 Existing Road Segment Level of Service 1-135

Table 1.4-4 Projected Patrons of Millbury Station - Year 1996 1-143

Table 1.4-5 MBTA Ridership Distribution 1-144

Table 1.4-6 1996 Peak Hour Signalized Intersection Level of Service 1-152

Table 1.4-7 1996 Peak Hour Unsignalized Intersection Level of Service 1-153

Table 1.4-8 1996 Peak Hour Road Segment Level of Service 1-154

Table 1.4-9 1996 Peak Generator Hour Signalized Intersection Level of Service 1-156

Table 1.4-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-157

Table 1.4-11 1996 Peak Generator Hour Road Segment Level of Service 1-158

Table 1.4-12 1996 "Build" Condition - 10% Analysis 1-159

Table 1.4-13 Projected Patrons of Millbury Station Only Year 1996 1-160

Table 1.4-14 MBTA Ridership Distribution (Millbury Station Only) 1-161

Table 1.4-15 1996 Peak Hour Signalized Intersection Level of Service (Millbury Station Only) 1-168

Table 1.4-16 1996 Peak Hour Unsignalized Intersection Level of Service (Millbury Station Only) 1-170

Table 1.4-17 1996 Peak Hour Road Segment Level of Service (Millbury Station Only) 1-171

Table 1.4-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Millbury Station Only) 1-172

Table 1.4-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Millbury Station Only) 1-173

Table 1.4-20 1996 Peak Generator Hour Segment Level of Service (Millbury Station Only) 1-174

Table 1.4-21 1996 "Build" Condition - 10% Analysis (Millbury Station Only) 1-175

Table 1.4-22 Projected Patrons of Millbury Station - Year 2001 1-181

Table 1.4-23 MBTA Ridership Distribution 1-183

Table 1.4-24 2001 Peak Hour Signalized Intersection Level of Service 1-190

Table 1.4-25 2001 Peak Hour Unsignalized Intersection Level of Service 1-192

Table 1.4-26 2001 Peak Hour Road Segment Level of Service 1-193

Table 1.4-27 2001 Peak Generator Hour Signalized Intersection Level of Service 1-194

Table 1.4-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-195

Table 1.4-29 2001 Peak Generator Hour Road Segment Level of Service 1-196

Table 1.4-30 2001 "Build" Condition - 10% Analysis 1-197

Table 1.5-1 1992 Unsignalized Intersection Level of Service 1-209

Table 1.5-2 1992 Existing Road Segment Level of Service 1-210

Table 1.5-3 Projected Patrons of Grafton Station - Year 1996 1-216

Table 1.5-4 MBTA Ridership Distribution at Grafton Station Year 1996 1-217

Table 1.5-5 1996 Peak Hour Signalized Intersection Level of Service 1-224

Table 1.5-6 1996 Peak Hour Unsignalized Intersection Level of Service 1-225

Table 1.5-7 1996 Peak Hour Road Segment Level of Service 1-226

Table 1.5-8 1996 Peak Generator Hour Signalized Intersection Level of Service 1-226

Table 1.5-9 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-227

Table 1.5-10 1996 Peak Generator Hour Road Segment Level of Service 1-228

Table 1.5-11 1996 "Build" Condition - 10% Analysis 1-229

Table 1.5-12 Projected Patrons of Grafton Station Only Year 1996 1-230

Table 1.5-13 MBTA Ridership Distribution - Grafton Station Only Year 1996 1-231

Table 1.5-14 1996 Peak Hour Signalized Intersection Level of Service (Grafton Station Only) 1-238

Table 1.5-15 1996 Peak Hour Unsignalized Intersection Level of Service (Grafton Station Only) 1-239

Table 1.5-16 1996 Peak Hour Road Segment Level of Service (Grafton Station Only) 1-240

Table 1.5-17 1996 Peak Generator Hour Signalized Intersection Level of Service (Grafton Station Only) 1-240

Table 1.5-18 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Grafton Station Only) 1-241

Table 1.5-19 1996 Peak Generator Hour Road Segment Level of Service (Grafton Station Only) 1-242

Table 1.5-20 1996 "Build" Condition - 10% Analysis (Grafton Station Only) 1-243

Table 1.5-21 Projected Patrons of Grafton Station Year 2001 1-244

Table 1.5-22 MBTA Ridership Distribution - Grafton Station Year 2001 1-249

Table 1.5-23 2001 Peak Hour Signalized Intersection Level of Service 1-255

Table 1.5-24 2001 Peak Hour Unsignalized Intersection Level of Service 1-256

Table 1.5-25 2001 Peak Hour Road Segment Level of Service 1-257

Table 1.5-26 2001 Peak Generator Hour Signalized Intersection Level of Service 1-257

Table 1.5-27 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-258

Table 1.5-28 2001 Peak Generator Hour Road Segment Level of Service 1-259

Table 1.5-29 2001 "Build" Condition - 10% Analysis 1-260

Table 1.6-1 1992 Existing Signalized Intersection Level of Service 1-268

Table 1.6-2 1992 Existing Unsignalized Intersection Level of Service 1-270

Table 1.6-3 1992 Existing Road Segment Level of Service 1-271

Table 1.6-4 Projected Patrons of Westborough Station - Year 1996 1-279

Table 1.6-5 MBTA Ridership Distribution 1-280

Table 1.6-6 1996 Peak Hour Signalized Intersection Level of Service 1-287

Table 1.6-7 1996 Peak Hour Unsignalized Intersection Level of Service 1-288

Table 1.6-8 1996 Peak Hour Road Segment Level of Service 1-289

Table 1.6-9 1996 Peak Generator Hour Signalized Intersection Level of Service 1-290

Table 1.6-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-291

Table 1.6-11 1996 Peak Generator Hour Road Segment Level of Service 1-292

Table 1.6-12 1996 "Build" Condition - 10% Analysis 1-293

Table 1.6-13 Projected Patrons of Westborough Station Only Year 1996 1-294

Table 1.6-14 MBTA Ridership Distribution (Westborough Station Only) 1-295

Table 1.6-15 1996 Peak Hour Signalized Intersection Level of Service (Westborough Station Only) 1-302

Table 1.6-16 1996 Peak Hour Unsignalized Intersection Level of Service (Westborough Station Only) 1-303

Table 1.6-17 1996 Peak Hour Road Segment Level of Service (Westborough Station Only) 1-304

Table 1.6-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Westborough Station Only) 1-305

Table 1.6-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Westborough Station Only) 1-306

Table 1.6-20 1996 Peak Generator Hour Road Segment Level of Service (Westborough Station Only) 1-307

Table 1.6-21 1996 "Build" Condition - 10% Analysis (Westborough Station Only) 1-308

Table 1.6-22 Projected Patrons of Westborough Station Year 2001 1-309

Table 1.6-23 MBTA Ridership Distribution 1-314

Table 1.6-24 2001 Peak Hour Signalized Intersection Level of Service 1-321

Table 1.6-25 2001 Peak Hour Unsignalized Intersection Level of Service 1-322

Table 1.6-26 2001 Peak Hour Road Segment Level of Service 1-323

Table 1.6-27 2001 Peak Generator Hour Signalized Intersection Level of Service 1-323

Table 1.6-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-324

Table 1.6-29 2001 Peak Generator Hour Road Segment Level of Service 1-325

Table 1.6-30 2001 "Build" Condition - 10% Analysis 1-326

Table 1.6-31 2001 Peak Hour Signalized Intersection Level of Service 1-328

Table 1.7-1 1992 Existing Signalized Intersection Level of Service 1-339

Table 1.7-2 1992 Existing Unsignalized Intersection Level of Service 1-341

Table 1.7-3 1992 Existing Road Segment Level of Service 1-343

Table 1.7-4 Projected Patrons of Southborough Station Year 1996 1-345

Table 1.7-5 MBTA Ridership Distribution 1-350

Table 1.7-6 1996 Peak Hour Signalized Intersection Level of Service 1-359

Table 1.7-7 1996 Peak Hour Unsignalized Intersection Level of Service 1-360

Table 1.7-8 1996 Peak Hour Road Segment Level of Service 1-361

Table 1.7-9 1996 Peak Generator Hour Signalized Intersection Level of Service 1-362

Table 1.7-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-363

Table 1.7-11 1996 Peak Generator Hour Road Segment Level of Service 1-364

Table 1.7-12 1996 "Build" Condition - 10% Analysis 1-365

Table 1.7-13 Projected Patrons of Southborough Station Only Year 1996 1-366

Table 1.7-14 MBTA Ridership Distribution (Southborough Station Only) 1-367

Table 1.7-15 1996 Peak Hour Signalized Intersection Level of Service (Southborough Station Only) 1-375

Table 1.7-16 1996 Peak Hour Unsignalized Intersection Level of Service (Southborough Station Only) 1-376

Table 1.7-17 1996 Peak Hour Road Segment Level of Service (Southborough Station Only) 1-377

Table 1.7-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Southborough Station Only) 1-378

Table 1.7-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Southborough Station Only) 1-379

Table 1.7-20 1996 Peak Generator Hour Road Segment Level of Service (Southborough Station Only) 1-380

Table 1.7-21 2001 "Build" Condition - 10% Analysis (Southborough Station Only) 1-381

Table 1.7-22 Projected Patrons of Southborough Station Year 2001 1-384

Table 1.7-23 MBTA Ridership Distribution 1-387

Table 1.7-24 2001 Peak Hour Signalized Intersection Level of Service 1-395

Table 1.7-25 2001 Peak Hour Unsignalized Intersection Level of Service 1-396

Table 1.7-26 2001 Peak Hour Road Segment Level of Service 1-397

Table 1.7-27 2001 Peak Generator Hour Signalized Intersection Level of Service 1-398

Table 1.7-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-399

Table 1.7-29 2001 Peak Generator Hour Road Segment Level of Service 1-400

Table 1.7-30 2001 "Build" Condition - 10% Analysis 1-401

Table 1.8-1 1992 Existing Signalized Intersection Level of Service 1-412

Table 1.8-2 1992 Existing Unsignalized Intersection Level of Service 1-415

Table 1.8-3 1992 Existing Road Segment Level of Service 1-417

Table 1.8-4 Projected Patrons of Ashland Station - Year 1996 1-424

Table 1.8-5 MBTA Ridership Distribution 1-425

Table 1.8-6 1996 Peak Hour Signalized Intersection Level of Service 1-433

Table 1.8-7 1996 Peak Hour Unsignalized Intersection Level of Service 1-435

Table 1.8-8 1996 Peak Hour Road Segment Level of Service 1-436

Table 1.8-9 1996 Peak Generator Hour Signalized Intersection Level of Service 1-439

Table 1.8-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-440

Table 1.8-11 1996 Peak Generator Hour Road Segment Level of Service 1-441

Table 1.8-12 1996 "Build" Condition - 10% Analysis 1-442

Table 1.8-13 Projected Patrons of Ashland Station - Year 1996 (Ashland Station Only) 1-444

Table 1.8-14 MBTA Ridership Distribution (Ashland Station Only) 1-445

Table 1.8-15 1996 Peak Hour Signalized Intersection Levels of Service (Ashland Station Only) 1-452

Table 1.8-16 1996 Peak Hour Unsignalized Intersection Level of Service (Ashland Station Only) 1-454

Table 1.8-17 1996 Peak Hour Road Segment Level of Service (Ashland Station Only) 1-455

Table 1.8-18 1996 Peak Generator Hour Signalized Intersection Levels of Service (Ashland Station Only) 1-458

Table 1.8-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Ashland Station Only) 1-459

Table 1.8-20 1996 Peak Generator Hour Road Segment Level of Service (Ashland Station Only) 1-460

Table 1.8-21 1996 Condition - 10% Analysis (Ashland Station Only) 1-462

Table 1.8-22 Projected Patrons of Ashland Station - Year 2001 1-465

Table 1.8-23 MBTA Ridership Distribution 1-468

Table 1.8-24 2001 Peak Hour Signalized Intersection Levels of Service 1-475

Table 1.8-25 2001 Peak Hour Unsignalized Intersection Level of Service 1-478

Table 1.8-26 2001 Peak Hour Road Segment Level of Service 1-479

Table 1.8-27 2001 Peak Generator Hour Signalized Intersection Levels of Service 1-480

Table 1.8-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-482

Table 1.8-29 2001 Peak Generator Hour Road Segment Level of Service 1-483

Table 1.8-30 2001 "Build" Conditions - 10% Analysis 1-484

Table 1.9-1 1992 Existing Signalized Intersection Level of Service 1-495

Table 1.9-2 1992 Existing Unsignalized Intersection Level of Service 1-498

Table 1.9-3 1992 Existing Road Segment Level of Service 1-500

Table 1.9-4 Projected Patrons of Ashland Station - Year 1996 1-507

Table 1.9-5 MBTA Ridership Distribution 1-508

Table 1.9-6 1996 Peak Hour Signalized Intersection Level of Service 1-516

Table 1.9-7 1996 Peak Hour Unsignalized Intersection Level of Service 1-518

Table 1.9-8 1996 Peak Hour Road Segment Level of Service 1-519

Table 1.9-9 1996 Peak Generator Hour Signalized Intersection Level of Service 1-521

Table 1.9-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service 1-522

Table 1.9-11 1996 Peak Generator Hour Road Segment Level of Service 1-523

Table 1.9-12 1996 "Build" Condition - 10% Analysis 1-524

Table 1.9-13 Projected Patrons of Ashland Station - Year 1996 (Ashland Station Only) 1-526

Table 1.9-14 MBTA Ridership Distribution - (Ashland Station Only) 1-527

Table 1.9-15 1996 Peak Hour Signalized Intersection Levels of Service (Ashland Station Only) 1-534

Table 1.9-16 1996 Peak Hour Unsignalized Intersection Level of Service (Ashland Station Only) 1-536

Table 1.9-17 1996 Peak Hour Road Segment Level of Service (Ashland Station Only) 1-537

Table 1.9-18 1996 Peak Generator Hour Signalized Intersection Levels of Service (Ashland Station Only) 1-539

Table 1.9-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Ashland Station Only) 1-540

Table 1.9-20 1996 Peak Generator Hour Road Segment Level of Service (Ashland Station Only) 1-541

Table 1.9-21 1996 Condition - 10% Analysis (Ashland Station Only) 1-542

Table 1.9-22 Projected Patrons of Ashland Station - Year 2001 1-548

Table 1.9-23 MBTA Ridership Distribution 1-549

Table 1.9-24 2001 Peak Hour Signalized Intersection Levels of Service 1-556

Table 1.9-25 2001 Peak Hour Unsignalized Intersection Level of Service 1-558

Table 1.9-26 2001 "Build" Peak Hour Road Segment Level of Service 1-559

Table 1.9-27 2001 Peak Generator Hour Signalized Intersection Levels of Service 1-560

Table 1.9-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service 1-562

Table 1.9-29 2001 "Build" Peak Generator Hour Road Segment Level of Service 1-563

Table 1.9-30 2001 "Build" Condition - 10 % Analysis 1-564

TECHNICAL APPENDICES

SECTION 1.0 TRAFFIC ANALYSIS

This section presents the full traffic analysis conducted for the Draft Environmental Impact Report (DEIR). The analysis was conducted in accordance with guidelines established by MEPA. A separate analysis was conducted for each of the proposed commuter rail stations. The streets and intersections which were studied were selected based on the locations outlined in the Certificate of the Secretary of Environmental Affairs as well as locations identified as particular concern to the various communities.

The analysis is presented for the existing condition as well as the years 1996 and 2001 assuming full build conditions. In addition a separate analysis was prepared for each station for the year 1996 assuming that station was the only station in service by 1996. This is presented as the "Single Station Only" analysis.

The analysis was prepared for two periods, the peak roadway hours and the peak site generator hours. The peak roadway hours are those periods when traffic conditions are heaviest. The peak site generator hours are those periods when usage of the commuter rail stations is heaviest.

In order to ascertain the traffic impacts of building the commuter rail stations both "No Build" and "Build" conditions are presented, in accordance with MEPA procedures.

APPENDICES

SECTION 1.0 TRAFFIC ANALYSIS

1.1 Analysis Methodology

Level of Service - General Description

Level of Service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream, and the perception of these conditions by motorists and/or passengers. A level of service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. Level of service is defined for each type of facility for which analysis procedures are available. These facilities include: signalized intersections, unsignalized intersections, roadway segments, merge and diverge areas, weaving areas, etc.. They are given letter designations, from A to F, with level of service A representing the best operating conditions and level of service F representing the worst.

The analysis procedure and level of service definitions were developed by the Institute Of Transportation Engineers. The analysis procedures are found in the "1985 Highway Capacity Manual, Special Report 209", published by the Transportation Research Board.

There are several computer programs available to aide in level of service analysis. The program preferred by MEPA for the analysis of intersections is called CINCH. CINCH automates the analysis procedures set forth in the 1985 Highway Capacity Manual. This software package was utilized for the analysis of signalized and unsignalized intersections in this Environmental Impact Report.

Level of Service for Signalized Intersections

Level of service for signalized intersections is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption and lost travel time.

Specifically, level-of-service criteria are stated in terms of average stopped delay per vehicle for a 15-minute analysis period.

Delay may be measured in the field, or may be estimated using procedures presented in the 1985 Highway Capacity Manual. Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the volume-to-capacity (v/c) ratio of the lane group or approach in question.

Level-of-Service A

describes operations with very low delay, i.e., less than 5.0 seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

Level-of-Service B

describes operations with delay in the range of 5.1 to 15.0 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.

Level-of-Service C

describes operations with delay in the range of 15.1 to 25.0 seconds per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear in this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.

Level-of-Service D

describes operations with delay in the range of 25.1 to 40.0 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, longer cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

Level-of-Service E

describes operations with delay in the range of 40.1 to 60.0 seconds per vehicle. This is considered to be the limit of acceptable delay. The high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

Level-of-Service F

describes operations with delay in excess of 60.0 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with over saturation, i.e., when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios above 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be contributing causes to such delay levels.

Source: *Chapter 9, 1985 Highway Capacity Manual, Transportation Research Board Special Report 209.*

Level of Service for Unsignalized Intersections

Level of service criteria for unsignalized intersections are stated in very general terms. The criteria, shown in the following table, are based on the reserve, or unused, capacity of the lane in question. Reserve capacity is equal to the shared lane capacity of the lane minus the total traffic flow rate using the lane. Volume and capacity are stated as passenger cars per hour (pcph).

Table 1.1-1 Level of Service for Unsignalized Intersections

Reserve Capacity (pcph) Service	Level of Expected Delay to Minor Street Traffic
400+	A Little or no delay
300-399	B Short Traffic Delays
200-299	C Average Traffic Delays
100-199	D Long Traffic Delays
0-99	E Very Long Traffic Delays
< 0	F*

* *When demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing which may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improvement of the intersection.*

These criteria are stated in general terms, without specific numeric values for vehicle delay. It is not possible to compare the LOS of an unsignalized intersection with that of a signalized intersection in terms of specific delay values.

Source: *Chapter 10, 1985 Highway Capacity Manual, Transportation Research Board Special Report 209.*

Level of Service for Roadway Segments

The LOS rating for a roadway segment differs from ratings assigned to signalized and unsignalized intersections. The LOS rating "E" for roadway segments starts at 57% of the total segment capacity. The segments being analyzed for the Commuter Rail Extension Project (two lane segments) have a maximum capacity of approximately 2,600 vehicles per hour, depending on roadway geometrics. Thus, the LOS rating "E" has a range of 1,482 vehicles (with reserve capacity of 1,118) to 2,600 vehicles (with a reserve capacity of 0). Therefore, it becomes necessary to choose a point within the "E" range where the reserve capacity becomes critical. It was determined that a reserve capacity of 600 vehicles would guarantee that 21.5% of the reserve capacity was still available. This was chosen as the critical point and any roadway segment with a reserve capacity of less than 600 vehicles was considered to have an unacceptable level of service.

Source: *Chapter 8, 1985 Highway Capacity Manual, Transportation Research Board Special Report 209.*

Capacity Adjustment for Railroad Gate Closings

Several at-grade railroad crossings exist within the study area. When a train crosses a roadway, gates are utilized to close the roadway to vehicular traffic. This closing allows for the safe co-existence of railroad and roadway traffic, at the expense of roadway or intersection capacity. When analyzing a signalized intersection which is influenced by an active railroad crossing controlled by a gate, it is necessary to account for the additional lost time in the analysis. Chapter 12 of the "1985 Highway Capacity Manual", Transit Capacity, gives the following relationship to equate passenger cars per lane to the loss time due to transit vehicles crossing the roadway.

$$\text{Passenger Car Equivalent (pce)} = g/C \times (\text{Loss Time} + 6) / 2$$

Where g = effective green time
C = Cycle length
Loss Time = time gate is closed in seconds.

When analyzing a roadway segment or an unsignalized intersection, the term g/C is equal to one (1). For one minute, or 60 seconds of loss time (gate closed) on a road segment, the directional volumes would be adjusted by adding 33 passenger cars to the traffic stream.

At a signalized intersections the additional 33 passenger cars per minute of lost time is adjusted by multiplying by the g/C ratio on the affected intersection approach. This method results in a trial and error method of analysis if an optimized solution is

being calculated. An alternative to adjusting the traffic volume is to reduce the Ideal Saturation Flow rate by 33 vehicles per 1 minute of expected gate closing for the lanes effected by the gate closings. In this alternative analysis procedure the capacity is reduced in one of the first steps of the analysis procedure thereby making the adjustment to the output.

For the signalized intersections which required an adjustment to account for the gate closings due to train traffic the Ideal Saturation Flow Rate was adjusted in the analysis.

Background Traffic Growth

Existing traffic volumes in a study area will typically increase over time. These increases vary depending on many factors the most significant being the construction of new developments, both commercial and retail, within the study area. Background traffic growth will also occur due to vehicles accessing developments outside of the study area via local roadways. Local socio/demographic factors such as increases in average automobile ownership per household, growth in employment, and population growth will effect the growth rate of the background traffic.

The population projections for this decade, 1991 to 2000 and the next decade, 2001 to 2010 were done for the Commonwealth based primarily on U.S. Census data. These projections indicate very low to slightly negative population growth for the communities in the proposed rail corridor.

The economic projections for employment in the near future are optimistically hopeful. Stabilization and slow growth are anticipated. The latest projected employment figures revealed a decline of 1.5% in 1992 and estimated growth to be at +1.6% by 1998.

Typically a good key indicator of the short term background growth is the traffic growth as measured at a trend station if the station is not close to large projects which effect the volume of traffic at the trend station. Almost all count stations on non-interstate freeways, are showing traffic growing at a negative 1 to 2 percent per year, for the years 1987 to 1992. Trend station number 307 on Route 9 in Westborough is the exception. During last five years (1987 - 1992) the annual growth rate was 2.1% per year at this station. For the last three years (1989 - 1992), however, the annual growth rate at this station has been 1.2% per year.

Recent traffic growth at Trend Station 307 seems to be affected by site specific traffic along or just off of Route 9 in Westborough. Such sites as the Speedway Plaza, Sam's Club, Astra Pharmaceuticals, and other numerous small employment and shopping centers appear to be skewing the traffic growth data at the trend station.

The population projections, economic projections, and recent traffic growth history all indicate relatively little growth in recent years. To yield a more conservative estimate of growth the 1992/93 existing traffic volumes were factored by 0.5% per year through 1996.

The background growth rate from 1996 to 2001 was increased to 1.5% per year to better reflect the average long term growth rate and the projected growth in employment for this area.

In addition to normal background traffic growth, large projects, which would be considered Major Traffic Generators, proposed within the study area contribute to increased traffic volumes. Volumes from these projects are added to the normal background traffic growth to develop baseline or "No Build" traffic volumes.

Station Ridership - Trip Generation

The Central Transportation Planning Staff (CTPS) developed the expected ridership for the extension of the Framingham Line to Worcester for the years 1996, 2001, 2006, and 2011 from transportation data relevant to the Boston Metropolitan Area.

The projections are based on CTPS's regional travel demand forecasting model. A detailed explanation of the model and the process used can be found in the "Commuter Rail Extension Feasibility Study: Framingham to Worcester, Milford, & Marlborough", by Stone & Webster Civil & Transportation Services, Inc., January 1990. The projections were revised in May of 1994 to included the revised station locations and travel demand data from the 1990 census. The output from the model contained the expected ridership at each station for the design years, broken down by the expected communities of origin. The design year of 2016 was not analyzed since current projections indicate no increase in downtown Boston traffic between the years 2011 and 2016.

The following table lists the CTPS projected inbound or outbound ridership per station and the community of ridership origin without a regional station at Route 495.

Table 1.1-2 Expected Ridership Without A Regional Station

Station/Source Town	Year			
	1996	2001	2006	2011
Ashland Station	738	837	962	1093
Ashland	377	418	471	523
Holliston	279	299	320	344
Hopkinton	47	53	65	76
Marlborough	11	25	43	65
Southborough	24	31	41	53
Upton	0	7	12	18
Westborough	0	4	10	14
Southborough Station	550	553	550	553
Hopkinton	92	95	90	94
Marlborough	228	232	235	238
Southborough	90	94	97	99
Upton	80	76	74	71
Westborough	60	56	54	51
Westborough Station	216	230	246	263
Northborough	90	96	102	109
Shrewsbury	64	70	77	83
Upton	40	41	43	46
Westborough	22	23	24	25

Table 1.1-2 Expected Ridership Without A Regional Station

Station/Source Town	Year			
	1996	2001	2006	2011
Grafton Station	116	126	136	149
Boylston	17	18	19	20
Grafton	37	41	45	50
Northbridge	28	30	32	35
Shrewsbury	18	20	22	24
Sutton	16	17	18	20
Millbury Station	149	162	178	195
Auburn	27	33	41	51
Charlton	17	18	19	20
Millbury	26	27	29	30
Oxford	17	19	21	23
Worcester	62	65	68	71
Worcester Station	369	391	421	448
Auburn	18	22	27	34
Holden	54	58	62	67
Leicester	4	4	5	5
Paxton	10	11	12	13
Spencer	4	4	5	5
West Boylston	32	34	37	40
Worcester	247	258	273	284
Total A.M. Or P.M. Ridership	**2,138**	**2,299**	**2,493**	**2,701**

These projections were reduced by 6% to obtain the A.M. and P.M. peak period ridership, since CTPS's data indicates that 6% of the current commuter rail ridership occurs outside of the peak period of commuting.

Table 1.1-3 lists the expected inbound and outbound ridership for each station and the community of origin assuming a regional station is constructed at Route 495. Although ridership projections are shown for the year 2001, it is unlikely that a regional station would be in place at that time. Environmental issues, access issues

and other concerns would likely delay construction of a regional station to beyond 2001.

Table 1.1-3 Expected Ridership with a Regional Station

Station/Source Town	Year		
	2001	2006	2011
Ashland Station	717	791	867
Ashland	418	471	523
Holliston	299	320	344
Southborough Station	415	454	498
Hopkinton	117	126	136
Marlborough	203	223	245
Southborough	95	105	117
Regional Station	480	512	546
Berlin	5	5	5
Bolton	17	18	20
Clinton	36	39	42
Hopkinton	33	36	38
Hudson	42	46	49
Marlborough	57	63	69
Milford	64	68	72
Southborough	32	35	39
Upton	126	131	138
Westborough	68	71	74

Table 1.1-3 Expected Ridership with a Regional Station

Station/Source Town	Year		
	2001	2006	2011
Westborough Station	183	197	210
Northborough	96	102	109
Shrewsbury	70	77	83
Westborough	17	18	18
Grafton Station	126	136	149
Boylston	18	19	20
Grafton	41	45	50
Northbridge	30	32	35
Shrewsbury	20	22	24
Sutton	17	18	20
Millbury Station	162	178	195
Auburn	33	41	51
Charlton	18	19	20
Millbury	27	29	30
Oxford	19	21	23
Worcester	65	68	71
Worcester Station	391	421	434
Auburn	22	27	34
Holden	58	62	67
Leicester	4	5	5
Paxton	11	12	13
Spencer	4	5	5
West Boylston	34	37	40
Worcester	258	273	284
Total A.M. Or P.M. Ridership	**2,474**	**2,689**	**2,913**

All the proposed intermediate stations may not be constructed by the time proposed commuter rail service begins. Specifically, concerns have been expressed on the potential impacts associated with increased traffic to those stations that are on line.

To accommodate these concerns a separate analysis was conducted for the year 1996 conditions. Each intermediate station was analyzed as if it were the only station constructed by 1996. This results in a worst case analysis for traffic impacts at each station. The analysis also assumed that adequate parking would be available at the station.

The expected ridership per station is listed by town of origin in Table 1.1-4.

Table 1.1-4 Expected Ridership of 1996 Single Station Only Analysis

Station/Source Town	Ridership
Ashland Station	1041
Ashland	377
Holliston	279
Hopkinton	98
Marlborough	182
Southborough	81
Westborough	24
Southborough Station	636
Grafton	18
Hopkinton	116
Marlborough	192
Milford	30
Northborough	54
Southborough	117
Upton	26
Westborough	83

Table 1.1-4 Expected Ridership of 1996 Single Station Only Analysis

Station/Source Town	Ridership
Westborough Station	506
Berlin	5
Boylston	19
Grafton	39
Millbury	4
Northborough	95
Northbridge	28
Shrewsbury	82
Sutton	18
Upton	126
Westborough	90
Grafton Station	444
Auburn	22
Boylston	18
Charlton	18
Grafton	40
Millbury	29
Northborough	62
Northbridge	30
Oxford	20
Shrewsbury	89
Sutton	17
Upton	30
Westborough	18
Worcester	51

Table 1.1-4 Expected Ridership of 1996 Single Station Only Analysis

Station/Source Town	Ridership
Millbury Station	347
Auburn	29
Boylston	17
Charlton	21
Grafton	37
Millbury	30
Northbridge	28
Oxford	19
Shrewsbury	82
Sutton	16
Worcester	68
Worcester Station	593
Auburn	47
Boylston	15
Charlton	15
Holden	57
Leicester	4
Millbury	23
Oxford	15
Paxton	11
Shrewsbury	41
Spencer	4
West Boylston	34
Worcester	327

Ridership Per Train

Due to the nature of rail service and its relationship to employment start times in Boston, ridership will not be distributed evenly on each train. There is no published data for distributing commuter ridership between trains. This lack of published data necessitated development of equations for ridership per train for this specific project, based on local ridership data.

The use of the existing percentages of ridership from the Framingham Line directly to the new trains at the new stations would be accurate only if the new stations were to be served by extending the existing train schedule out to the new stations. If this were true, the additional service would result in no change in the number of trains or their arrival and departure times.

The express service from Framingham to Back Bay necessitates new A.M. arrival times and new P.M. departure times since the express trains will be using the same tracks as the existing service. The changes in the number of peak hour trains serving the expanded suburban service from the existing Framingham Line combined with the changed arrival and departure times, make it necessary to derive equations for the determination of ridership, as opposed to directly applying the percentages of ridership from the existing Framingham Line.

Using the existing Framingham Lines A.M. and P.M. weekday peak hour train ridership data, it was possible to determine an A.M. and a P.M. equation for the expected percentage of ridership per train. A "best fit" straight line equation was derived from the existing data for the A.M. and P.M. periods.

The A.M. equation is based on the need to arrive at work for a specific time. The trains arriving at South Station between 6:50 and 9:20 were counted as being in the A.M. peak hours.

The P.M. equation is based on departing work at a specific time. The trains departing South Station between 4:10 and 6:20 were counted as being in the P.M. peak hours.

With the data generated from these equations it is possible to determine the approximate number of commuters on each train and thus determine at what time of the day they will enter or exit the local commuter rail station by using the expected train schedule. The assumption was made that the percentage of ridership from each local station would be the same for all stations.

The A.M. equation is derived around 2.67 hours of service time for the A.M. peak hours, where as the P.M. equation is derived around 2.25 hours of service time for the P.M. peak hours.

The equation for the first A.M. train is:

Percentage of Passengers on Train # 1 =

(Arrival Time - Beginning of A.M. Peak) x .6483 + .1812

Where:
- Time is in units of minutes
- The beginning of the A.M. Peak is 6:40
- The correlation coefficient is .9969

Percentage = (7:10 - 6:40) x .6483 + .1812 = 19.6%

The equation for subsequent A.M. trains is:

Percentage of passengers on a train =

[(Arrival Time - Beginning of A.M. Peak) x .6483 + .1812] -
[(Arrival Time of Previous train - Beginning of A.M. Peak) x .6483 + .1812]

The equation for the first P.M. train is:

Percentage of Passengers on Train #1 =

(Departure Time - Beginning of P.M. Peak) x .7706 - 1.3679

Where:
- The beginning of P.M. Peak is 4:05

Percentage = (4:25 - 4:05) x .7706 - 1.3679 = <u>14.0%</u>

The equation for subsequent P.M. trains is:

Percentage of passengers on a train =

[(Departure Time - Beginning of P.M. Peak) x .7706 - 1.3679] -
[(Departure Time of previous train - Beginning of P.M. Peak) x .7706 - 1.3679]

Using the A.M. and P.M. equations for percentage of ridership developed from the existing Framingham Line the following percentage of ridership per train was estimated.

Table 1.1-5 Percentage of Passengers

Train*	Arrival Time A.M.	Departure Time P.M.	Percentage of Passengers Project Stations
502	06:55		
502A	07:10		19.6%
504	07:50		
504A	08:00		32.4%
506	08:35		—
506A	08:50		32.5%
508	09:15		
510	09:20		15.5%
515		3:00	
515A		4:25	14.0%
517		4:30	
519		4:55	
519A		5:00	23.2%
521		5:25	
523A		5:30	23.1%
449 Amtrak		5:55	
521A		6:10	34.7%
523		6:20	5.0%

* *Per Dyer March 25, 1993 Plan*

Vehicle Trip Generation

Road segments and intersections are counted and analyzed in 15 minute periods. Typically counters begin a 15 minute period on the hour, 1/4 hour, 1/2 hour, or 3/4 hour. Analysis for a one hour period would be for four consecutive 15 minute periods. Examples would be: 7:00 to 8:00, 7:15 to 8:15, 7:30 to 8:30, or 7:45 to 8:45.

With the expected percentage of ridership per train, the proposed train schedule, expected Kiss'n'Ride patrons per station, expected vehicle parking demand per station, and the following arrival and departure assumptions, it is possible to estimate when the site's A.M. and P.M. peak generating hour will occur. The site generation

peak hours do not necessarily coincide with the local roadway peak hours. The preceding data can also be used to determine the site's entering and exiting volume for the peak generating hours, or any specific hour such as the local area's A.M. or P.M. peak hour.

For arrivals, it is assumed that all commuters will arrive at the station uniformly over a 15 minute period beginning 20 minutes before the train is scheduled to depart for Boston. For departures, it is assumed that all commuters will exit uniformly over a 15 minute period beginning within 1 to 3 minutes of the train arriving at a station.

The data in the following tables for the years 1996 and 2001 was derived using the above parameters.

Table 1.1-6 Year 1996 Vehicle Trips Generated

Station	A.M. (Inbound)		P.M. (Outbound)	
	Peak Generator Hour	Peak Hour	Peak Hour	Peak Generator Hour
	Trips	Trips	Trips	Trips
	7:15-8:15	**7:30-8:30**	**5:00-6:00**	**5:30-6:30**
Ashland				
Total	358	216	271	367
Entering	329	198	22	30
Exiting	29	18	249	337
	7:00-8:00	**7:30-8:30**	**4:45-5:45**	**5:30-6:30**
Southborough				
Total	295	205	120	303
Entering	254	177	17	42
Exiting	41	28	103	261
	7:00-8:00	**7:30-8:30**	**4:45-5:45**	**5:45-6:45**
Westborough				
Total	108	96	25	111
Entering	99	88	2	9
Exiting	9	8	23	102

Table 1.1-6 Year 1996 Vehicle Trips Generated

Station	A.M. (Inbound)		P.M. (Outbound)	
	Peak Generator Hour	Peak Hour	Peak Hour	Peak Generator Hour
	Trips	Trips	Trips	Trips
	6:45-7:45	7:30-8:30	4:45-5:45	5:45-6:45
Grafton				
Total	58	52	13	59
Entering	54	48	1	4
Exiting	4	4	12	55
	6:45-7:45	7:15-8:15	5:00-6:00	6:00-7:00
Millbury				
Total	74	65	17	76
Entering	68	60	1	6
Exiting	6	5	16	70

Table 1.1-7 Year 2001 Vehicle Trips Generated

Station	A.M. (Inbound)		P.M. (Outbound)	
	Peak Generator Hour	Peak Hour	Peak Hour	Peak Generator Hour
	Trips	Trips	Trips	Trips
	7:15-8:15	7:30-8:30	5:00-6:00	5:30-6:30
Ashland				
Total	407	245	309	418
Entering	374	225	25	34
Exiting	33	20	284	384

Table 1.1-7 Year 2001 Vehicle Trips Generated

Station	A.M. (Inbound)		P.M. (Outbound)	
	Peak Generator Hour	Peak Hour	Peak Hour	Peak Generator Hour
	Trips	Trips	Trips	Trips
	7:00-8:00	**7:30-8:30**	**4:45-5:45**	**5:30-6:30**
Southborough				
Total	298	207	121	306
Entering	256	178	17	43
Exiting	42	29	104	263
	7:00-8:00	**7:30-8:30**	**4:45-5:45**	**5:45-6:45**
Westborough				
Total	114	102	26	117
Entering	105	942	2	9
Exiting	9	8	24	108
	6:45-7:45	**7:30-8:30**	**4:45-5:45**	**5:45-6:45**
Grafton				
Total	62	56	14	64
Entering	58	51	1	5
Exiting	4	5	13	54
	6:45-7:45	**7:15-8:15**	**5:00-6:00**	**6:00-7:00**
Millbury				
Total	80	72	19	83
Entering	74	66	2	7
Exiting	6	6	17	76

Roadway Systems

The roadway systems within the project's study area and discussed in this report, include the full range of roadway types. These roadway types are defined as follows:

Limited Access Highways

Limited access or controlled access highways are multi-lane, divided roadways where the only access to the highway is at grade separated interchanges. Limited access highways are the highest order of roadways, allowing the highest travel speeds and highest volumes of traffic.

Major Divided State Highways

Major divided state highways have two or more lanes in each direction with a median barrier or separation between the opposing travel lanes. Turns to and from adjacent land uses are common and it is this feature that distinguishes this roadway type from limited access highways discussed above.

Undivided State Highways

Several undivided state highways serve the project area. Undivided state highways are numbered routes but are usually only two lanes wide (1 lane in each direction). These roads serve as the major roadways between cities and towns, and connect to the larger highways discussed above. Some sections of these state numbered routes are, in fact, locally owned and maintained roadways.

Arterial Roadways

Arterial roadways are important routes but are not designated as state numbered highway routes. Arterial roadways can carry significant volumes of traffic and often provide important connections between towns. Arterial roads will be identified and discussed individually as they relate to each of the proposed station locations.

Collector Streets

Collector streets are generally two-lane roads connecting between the areas of a town or adjoining towns or connecting between higher level roads. Collector streets may often appear to be completely residential in character. Collector roads often carry a greater percentage of through traffic than local traffic and are used by large trucks for local deliveries. The collector streets that may be affected by the proposed project are discussed in the traffic section of the separate chapters for each of the proposed station sites.

Subcollector Streets

Subcollector streets are generally two-lane roads connecting between collector streets or a subcollector street and a higher level of road. Subcollector streets often appear to be completely residential in character. Subcollector streets tend to see a large peak of traffic during the A.M. and P.M. rush hours and some occasional through truck traffic. Typically a subcollector street will become known to locals as a short cut to get somewhere locally. The subcollector streets that may be affected by the proposed project are discussed in the traffic section of the separate chapters for each of the proposed station sites.

Local Streets

Local streets are roadways whose function is to serve the adjacent land use. There are very few local streets in the project corridor. Local streets do not carry through traffic because local streets do not connect between higher level roads. Local streets do not generally provide any opportunity to be used as short cuts by through traffic. Truck traffic on local roads is limited to trucks making a delivery along the local road. The local streets in the vicinity of each of the station sites are discussed in the traffic section of separate chapters for each of the proposed station sites.

Minor Streets

Minor streets are short dead end streets ending in a cul-de-sac whose function is to serve the adjacent land use, which is typically residential only.

1.2 Worcester Station

Project Introduction

The proposed location for the Interim Worcester Commuter Rail station is east of Union Street at the Amtrak Station. Union Station when reconstructed will be the ultimate location for the Commuter Rail Station in the City of Worcester. For this analysis, it is expected that a 138 space parking lot will be constructed off of Shrewsbury Street with the addition of 47 parking spaces from the city owned parking lot along Grafton Street the site will have 185 parking spaces. This parking lot will be supplemented by two of the City owned parking lots along Grafton Street under Interstate 290 with an additional 138 parking spaces. All three parking lots will have a combined 323 parking spaces for commuter use.

The proposed station will consist of the existing Amtrack platform with the addition of a mini-high platform at the westerly end for handicapped access, a drop off area for Kiss'n'Ride patrons, adequate lighting for public safety, and landscaping. Access to the stations parking lot will be provided by a driveway connecting to Shrewsbury Street. Access to the additional parking lots off of Grafton Street will be by driveways to Franklin Street and Grafton Street.

Study Area

The study area for assessment of traffic impacts at this station is focused on the site's access to Shrewsbury Street and the westbound Shrewsbury Street intersection with the Washington Square Rotary. There have been numerous other traffic studies of the Washington Square area of the City of Worcester in recent years.

This area has been and is being studied by projects to construct the Fallon/St. Vincent Medical City, the Worcester Convention Center, the revitalize Galleria Mall, The City of Worcester's Gateway project, and the proposed intermodal transportation facility which includes a proposal to replace the Washington Square rotary with a signalized cross road intersection.

Data Collection

Traffic data from previous studies was used to obtain the existing traffic volumes. The expected A.M. and P.M. peak hour traffic volumes for the proposed site specific projects previously mentioned were added to the existing conditions to establish the year 1996 "No Build" traffic volumes.

The intersection of Shrewsbury Street with Mulberry Street and the Amtrak driveway was counted in December of 1989 for the City of Worcester I-290 access study. The intersection of Shrewsbury Street with the Washington Square rotary was counted in October of 1992 for the Fallon/St. Vincent Medical City traffic study. Analysis of Shrewsbury Street between the Washington Street rotary and Mulberry Street shows that the peak hour traffic volumes grew at negative 5.6 percent per year from 1989 to 1992.

The existing traffic data did not include the A.M. peak generator hour 6:30 to 7:30 A.M. and the P.M. peak generator hour 6:00 to 7:00 P.M.

The A.M. and P.M. peak hour existing conditions traffic volumes were determined for this analysis and are shown in Figures 1.2-1 and 1.2-2.

Year 1992 Existing Conditions

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The software program "CINCH" was used to perform the analysis. The computerized output of "CINCH" is available at the MBTA and MEPA. The analysis is of the A.M. and P.M. peak hours. The A.M. and P.M. peak generator hours were not analyzed due to the lack of existing traffic volume data, but it is expected that the A.M. and P.M. peak hours will be the worst condition as it has been most of the suburban station scenarios.

Levels of service for movements forced to wait for other movements to clear at unsignalized intersections are stated in terms of reserve capacity for the particular movement forced to wait. Reserve capacity is as the name implies the total capacity of a particular traffic movement minus the volume of traffic making that movement. A detailed description of level of service is provided in Section 1.1 of this report.

Two unsignalized intersections were analyzed and include the following:

Shrewsbury Street/Mulberry Street/Site Driveway

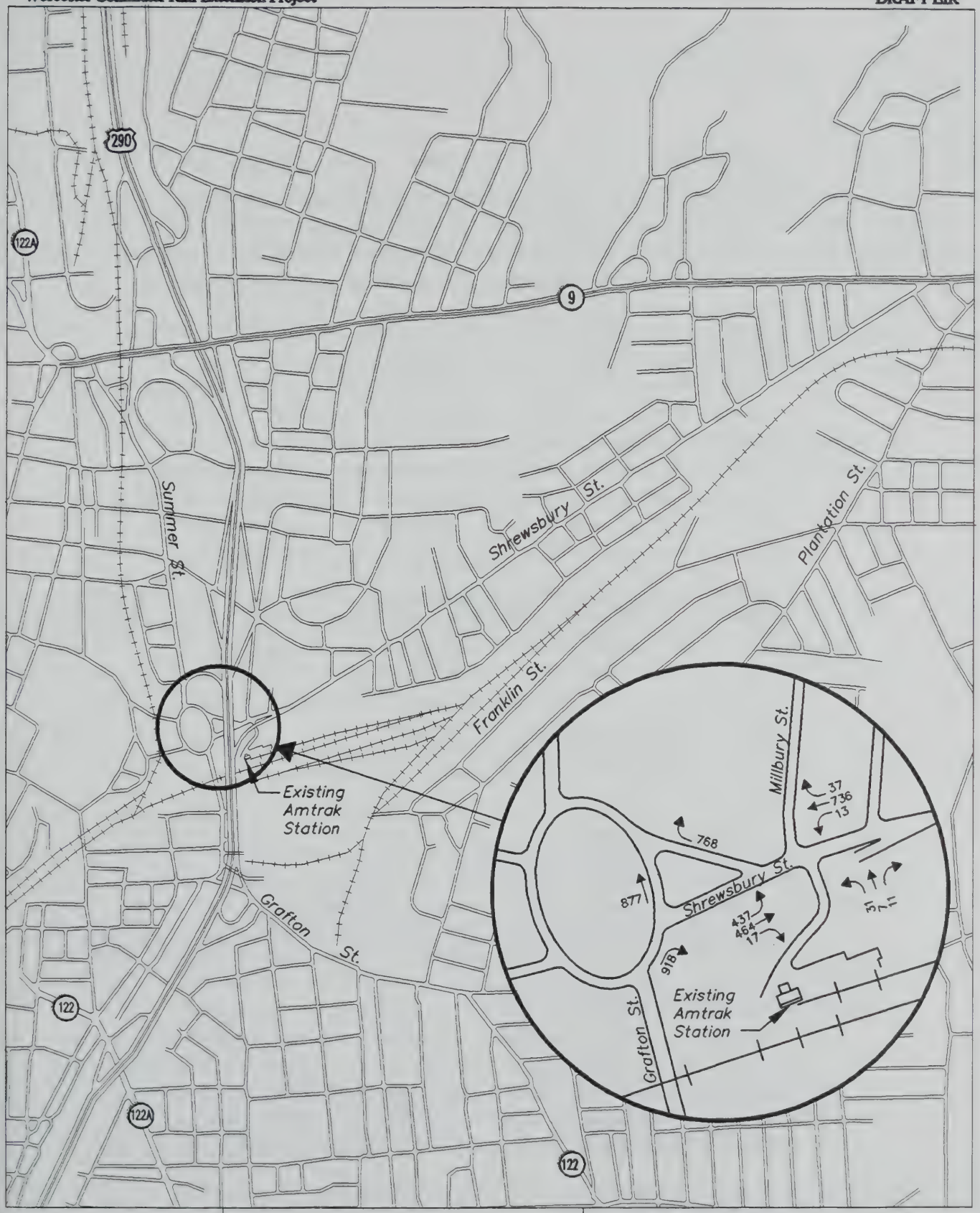
This intersection is a cross road intersection located to the east of I-290. Shrewsbury Street is an arterial road connecting Route 9 to Washington Square. Mulberry Street is a one way collector road connecting Shrewsbury Street to East Central Street and access to northbound I-290.

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

A.M. Peak Hour
7:30 - 8:30 A.M.
1992 Existing Conditions
INTERIM STATION, Worcester

FIGURE 1.2-1



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

P.M. Peak Hour
4:30 - 5:30 P.M.
1992 Existing Conditions
INTERIM STATION, Worcester

FIGURE 1.2-2

Washington Square Rotary/Shrewsbury Street

This "Y" intersection consists of the one way access to or from the rotary connecting to Shrewsbury Street. Traffic from the areas north, south, and west of the station would most likely travel through the rotary to enter the site. Traffic to areas south and west of the site would also most likely use the rotary to leave the site.

The results of the A.M. and P.M. peak hour analysis of the existing conditions for the unsignalized intersections are listed in Table 1.2-1. The table shows the LOS rating as well as the reserve capacity in vehicles, for each intersection movement analyzed. As shown in the table, most of the analyzed intersection movements operate at acceptable levels of service with poor levels of service at some individual movements. During the A.M. and P.M. peak hour the westbound Shrewsbury traffic attempting to access the rotary has a level of service rating of "F". In the P.M. peak hour the traffic exiting the existing parking lot has a level of service rating of "F" along with the eastbound traffic turning left to northbound Mulberry Street.

Table 1.2-1 1992 Unsignalized Intersection Level of Service

Worcester	Peak Hour	
	A.M.	P.M.
Washington Square Rotary		
WB Shrewsbury Street	F(-138)	F(-215)
Shrewsbury with Site DW		
LT from EB Shrewsbury	B(384)	F(-13)
LT from WB Shrewsbury	A(728)	A(611)
All from Site DW	D(113)	F(-49)

LOS (Reserve Capacity - Vehicles)

Safety Concerns and Accident History

The Worcester Police Department was contacted to determine if the intersections analyzed are a safety concern or high accident location. According to the Department, neither intersection is a serious safety concern or high accident location. The Massachusetts Highway Departments latest top 1,000 high accident intersection list for the Commonwealth was checked and neither intersection is on the list.

Year 1996 Conditions

To determine the impacts directly attributable to the proposed commuter rail station, conditions for the year 1996 were developed and analyzed with and without the commuter rail service in place. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It is assumed unless noted that no significant changes will occur to the study area road network. All roadways currently open for travel will remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

It is assumed that the proposed replacement of the Washington Square Rotary with a cross road intersection to be done with the revitalization of Union Station into an intermodal terminal will not take place until after the year 2001.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments proximate to the study area.
- Increases in existing traffic volumes due to population growth and development proximate to, but outside of the study area.

Through discussion with the City of Worcester and MEPA, it was determined that there are several projects which could be in place by the year 1996 or the year 2001.

The major projects which will generate the most traffic is the Fallon/St. Vincent Medical City project. Other smaller traffic generating projects are the convention center, the intermodal transportation facility, and the revitalized Galleria Mall.

The expected traffic volumes from these proposed facilities expected to be at the intersections analyzed were added to the base 1996 traffic volumes which were factored up from the 1992 existing conditions traffic volumes per the background traffic growth rate of plus 0.5 percent per year.

Recent historic traffic data reviewed to determine the background annual rate of growth within the study area shows flat to negative traffic growth on the non-interstate roadways with the City of Worcester since 1989.

This recent negative growth rate may be due to the economic down turn experienced throughout the region over the past years. Most economic indicators point towards a recovery, leading to lower unemployment, increase economic vitality, and hence higher growth in traffic volumes.

To account for this potential growth, and to yield a more conservative analysis, a background growth rate of 0.5 percent per year was applied to the 1992 existing conditions traffic volumes. Figures 1.2-3 and 1.2-4 show the projected 1996 "No Build" A.M. and P.M. traffic volumes.

The "No Build" traffic volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to the City of Worcester.

Year 1996 Trip Generation/Parking

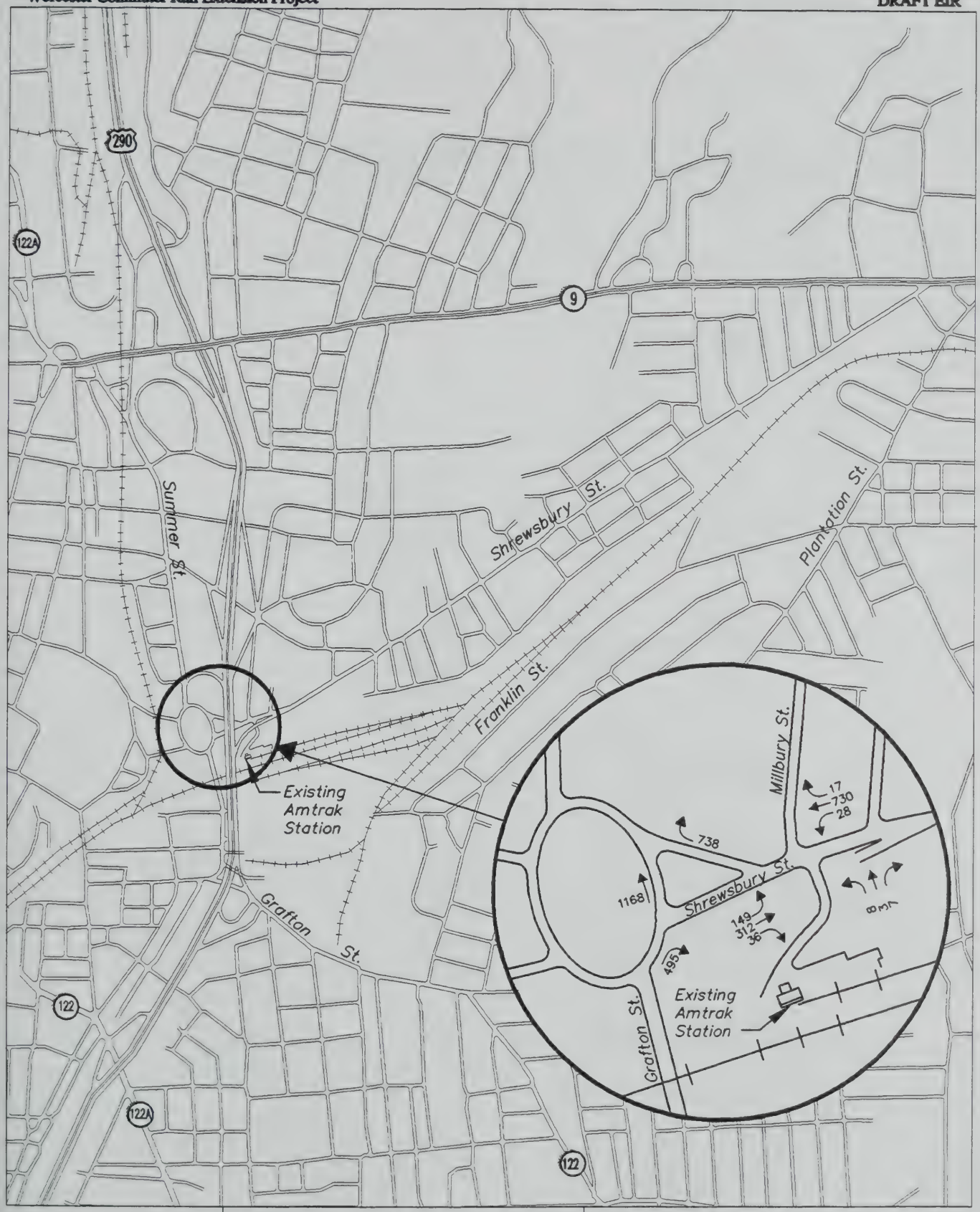
In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 1996, a total of 2,137 persons would utilize the railroad for daily round trip commuting into the Boston area if all the proposed suburban commuter rail stations are constructed.

By 1996, with the proposed basic or expanded service plan in place, the Worcester Station is expected to attract 369 daily round trip commuters. Of the expected 369 daily commuters, 347 are expected to travel during the peak commuting hours to or from the Boston area.

Of the 369 daily commuters 20 are expected to walk to and from the station, while an additional 28 will be dropped off. Based upon an average vehicle occupancy rate of 1.12, the remaining 321 Park'n'Ride patrons would result in a parking demand of 287 spaces.

The patrons who are projected to use the Worcester commuter rail station will likely reside within the towns of Auburn, Holden, Leicester, Paxton, Spencer, West Boylston, and the City of Worcester. Based on the proposed station locations, all 20 of the patrons who are expected to walk to the station will resident within the City of Worcester. The number of peak period patrons who originate from each of the above towns are shown in Table 1.2-2.

These ridership levels are expected to occur shortly after completion of the Worcester Station, therefore, these projections were used on the analysis of the 1996 "Build" conditions.



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 NO BUILD
INTERIM STATION, Worcester

FIGURE 1.2-3

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

P.M. Peak Hour
4:30 - 5:30 P.M.
1996 NO BUILD
INTERIM STATION, Worcester

FIGURE 1.2-4

Table 1.2-2 Projected Patrons of Worcester Station - Year 1996

Town	Riders*
Auburn	17
Holden	51
Leicester	4
Paxton	9
Spencer	4
West Boylston	30
Worcester	232**
TOTAL	**347**

* *Adjusted for peak period demand*
** *Includes 19 walk trips from Worcester*

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The peak period ridership will be divided between five inbound trains during the A.M. peak period and five outbound trains during the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure times in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.2-3 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.2-3 MBTA Ridership Distribution

Inbound Train	Patrons
502A	68
504A	112
506	79
506A	34
510	54
TOTAL	**347**
Outbound Train	**Patrons**
515A	49
519	81
521	80
521A	120
523	17
TOTAL	**347**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times, since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M.

The peak hours for the traffic entering or exiting the site is referred to as the peak generator hour. The peak generator hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Worcester Station. The arrival were estimated to occur uniformly over a 15 minute arrival period ending 5 minutes before the train departs for Boston. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 2 to 4 minutes on average.

In Worcester the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:30 to 5:30 P.M. with the proposed commuter rail schedule the peak generator hours for the commuter rail station will be from 6:30 to 7:30 A.M. and from 6:00 to 7:00 P.M.

Once the project generated vehicles were distributed over time, the resulting hourly totals were assigned to the study area roadway system. Patrons who reside in Worcester would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside the City of Worcester were assigned to the major routes leading from their town to the proposed station off of Shrewsbury Street.

Figure 1.2-5 shows the percentages of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

Upon implementation of the commuter rail service, commuters will shift from automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes will increase in the immediate vicinity of the station, but will decrease on Route 9 and the Mass Pike.

Year 1996 "Build" Traffic Volumes

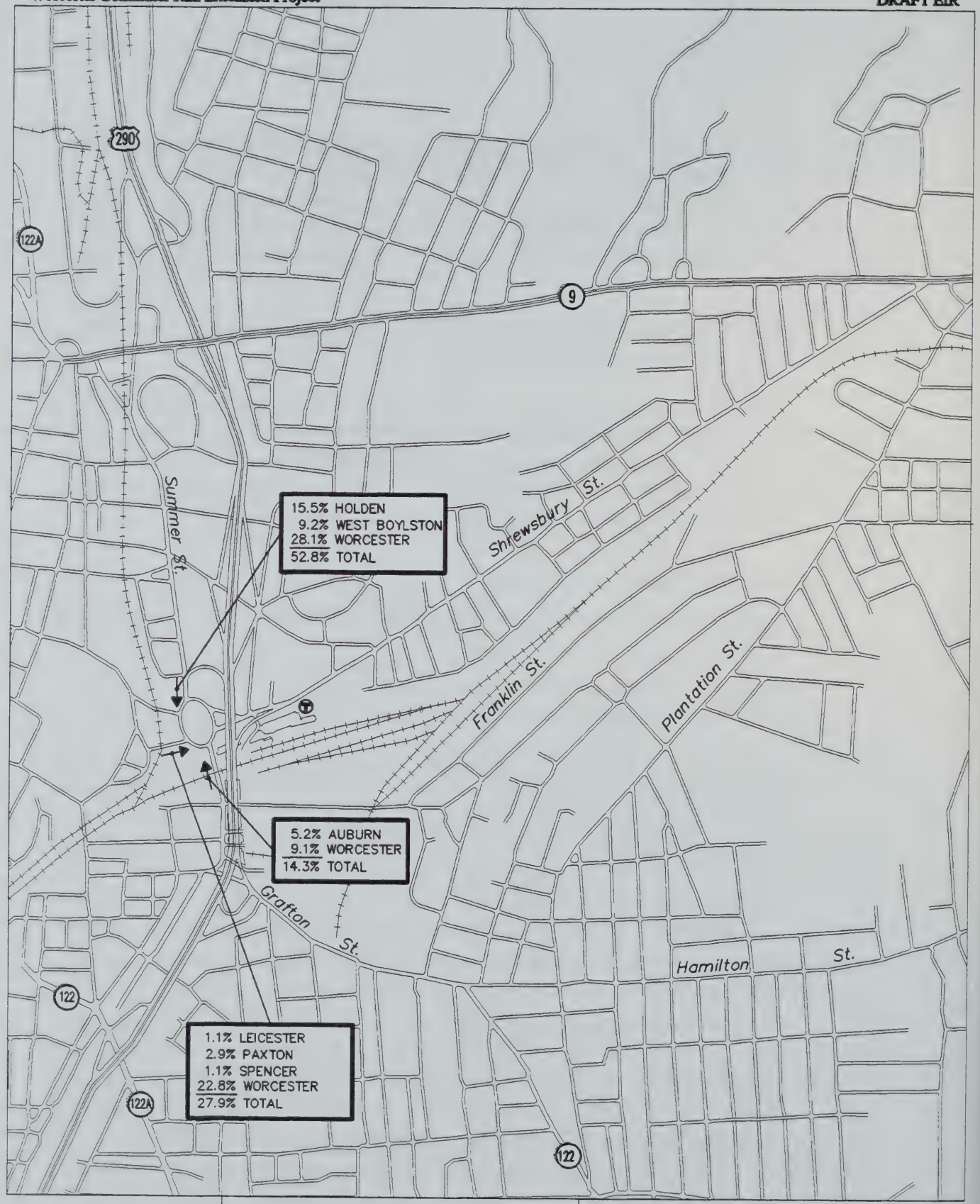
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Worcester station.

A portion of the traffic volumes heading to the proposed station would be diverted from traffic already travelling on Shrewsbury Street. The vehicles currently using Shrewsbury Street who are diverted into the station are called by-pass traffic. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways, thus this analysis is a "worst case" analysis. Figures 1.2-6 and 1.2-7 show the A.M. and P.M. 1996 "Build" peak hour traffic volumes, respectively.

Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics, etc. remain unchanged, unless noted.



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±

0 1200

Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
INTERIM STATION, Worcester

FIGURE 1.2-5

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD ALL STATIONS
INTERIM STATION, Worcester

FIGURE 1.2-6

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

P.M. Peak Hour
4:30 - 5:30 P.M.
1996 BUILD ALL STATIONS
INTERIM STATION, Worcester

FIGURE 1.2-7

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing conditions analysis. Results of the A.M. and P.M. peak hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.2-4. Under the 1996 "No Build" conditions most of the intersection movements are at undesirable levels of service ratings. The access to the rotary from westbound Shrewsbury Street is at level of service rating of "F" in both the A.M. and P.M. peak hours. The level of service rating for the eastbound Shrewsbury Street traffic turning left to northbound Mulberry Street is "F" in the P.M. peak hour and the traffic exiting the site currently a city parking lot and the Amtrak Station will have a level of service rating of "E" in the A.M. peak hour and a "F" on the P.M. peak hour.

Table 1.2-4 1996 Peak Hour Unsignalized Intersection Level of Service

Worcester	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Washington Square Rotary				
WB Shrewsbury Street	F(-363)	F(-453)	F(-357)	F(-453)
Shrewsbury with Site DW				
LT from EB Shrewsbury	C(289)	F(-121)	C(289)	F(-121)
LT from WB Shrewsbury	A(702)	A(566)	A(715)	A(591)
All from Site DW	E(67)	F(-50)	E(56)	E(29)

LOS (Reserve Capacity - Vehicles)

Under the 1996 "Build" conditions the level of service rating don't change except for the P.M. peak hour level of service rating for the site's access to Shrewsbury Street, which improves to "E" from "F" because there is no appreciable traffic from the commuter rail station until after 5:35 P.M. when the first evening peak period train arrives from Boston.

Year 1996 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.2-5 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak hours.

As shown in Table 1.2-5 no intersections during both the A.M. and P.M. peak hours will see ten percent or more of their traffic on the 1996 "Build" condition from the commuter rail station.

Table 1.2-5 1996 "Build" Condition Percentage of Site Traffic

Worcester	Peak Hours	
	A.M.	P.M.
Westbound Shrewsbury Street with the Washington Square Rotary	0.1%	0.0%
Shrewsbury with Site DW	4.7%	0.0%

Year 1996 Worcester Station Only

Interim service which is expected to commence in the Fall of 1994 is anticipated to attract up to 300 patrons on three trains leaving the Worcester Interim Station between 5:50 A.M. and 7:45 A.M. and returning from Boston between 5:50 P.M. and 7:00 P.M. The Notice of Project Change for Interim Service to Worcester Only, filed with the Secretary of Environmental Affairs on November 29, 1993 was approved in a Certificate issued on January 14, 1994. The traffic impacts associated with the stations diverted traffic were judged not to be significant, due to the fact that most of the traffic to or from the station will occur outside of the A.M. and P.M. peak hours.

The Secretary's Certificate does not allow for an increase in interim train service to basic or full until the section to be double track is constructed and at least one suburban station is on line for service with the interim Worcester Station. It is very unlikely that only one suburban station will come on line, thus a Grafton or Millbury Station will divert a large portion of the commuters that would be back tracking to Worcester keeping the traffic down to the 1996 "Build" conditions.

Year 2001 Conditions

Similar to the 1996 conditions, an analysis was conducted for the projected "No Build" and "Build" traffic conditions in the year 2001. Procedures and methodology for this analysis were the same as the 1996 conditions analysis. A detailed description of the analysis methodology is presented in Section 1.1 of this report.

Year 2001 "No Build" Traffic Volumes

To determine the year 2001 "No Build" traffic volume, the traffic volumes under the 1996 "No Build" conditions were adjusted based on anticipated growth in population

and employment throughout the region. A growth rate of 1.5 percent per year was applied to the 1996 "No Build" traffic volumes. The traffic volumes for the known site specific developments were added to the 1996 "No Build" traffic volume and increased at the 1.5 percent rate per year along with the 1996 base traffic volumes. Figure 1.2-8 and 1.2-9 show the projected year 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak hours.

Year 2001 Trip Generation/Parking

Minor shifting is expected to occur on the town of origin of the patrons utilizing the proposed Worcester Station as presented in the 1996 conditions. The Massachusetts Central Planning Staff (CTPS) performed an analysis of the projected ridership on the proposed commuter rail extension for the year 2001. CTPS projected that a total of 2,300 persons are expected to utilize the railroad for daily round trip commuting into the Boston area if all the proposed suburban commuter rail stations are constructed.

By the year 2001, the proposed Worcester Station is projected to attract 390 daily round trip commuters with the proposed full or basic service plans in operation. Of the expected 390 daily commuters, 371 are expected to travel during the peak commuting hours to or from the Boston area.

Of the 390 daily commuters 20 are expected to walk to and from the station, while an additional 30 will be dropped off. Based upon an average vehicle occupancy rate of 1.12, the remaining 340 Park'n'Ride patrons would result in a parking demand of 304 spaces. This is less than the proposed 385 supplied parking spaces leaving room for growth and the unusual days when more commuters use transit due to unusual weather or other conditions in which automobile commuters switch for the day to Mass transit.

The patrons who are projected to use the Worcester commuter rail station will likely reside within the towns of Auburn, Holden, Leicester, Paxton, Spencer, West Boylston, and the City of Worcester. Based on the proposed station location, all 20 of the patrons who are expected to walk to the station will reside within the City of Worcester. The number of peak period patrons who originate from each of the above towns are shown in Table 1.2-6. These ridership level are expected to occur by the year 2001, therefore, these projections were used in the analysis of the 2001 "Build" conditions.

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 NO BUILD
INTERIM STATION, Worcester

FIGURE 1.2-8

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

P.M. Peak Hour
4:30 - 5:30 P.M.
2001 NO BUILD
INTERIM STATION, Worcester

FIGURE 1.2-9

Table 1.2-6 Projected Patrons of Worcester Station - Year 2001

Town	Riders*
Auburn	23
Holden	55
Leicester	4
Paxton	10
Spencer	4
West Boylston	32
Worcester	243**
TOTAL	**371**

* *Adjusted for peak period demand*
** *Includes 19 walk trips from Worcester*

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston up to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are expected during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business will be in greater demand than those that depart at other times.

The total peak period ridership will be divided between five inbound trains during the A.M. peak period and five eastbound trains during the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using the regression equations based on arrival and departure times in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.2-7 lists the projected distribution of ridership based on arrival/departure times in Boston.

Table 1.2-7 MBTA Ridership Distribution Year 2001

Inbound Train	Patrons
502A	73
504A	119
506	85
506A	36
510	58
TOTAL	**371**
Outbound Train	**Patrons**
515A	52
519	86
521	86
521A	128
523	19
TOTAL	**371**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic and for the cost savings in parking fees and tolls. The commuters who shift to the commuter rail will shift their local departure and arrival time since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours of the site to lie totally or partially outside the standard hours of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M.

The peak hour for the traffic entering or exiting the site is referred to as the peak generator hour. The peak generator hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Worcester Station the arrivals were estimated to occur uniformly over a 15 minute arrival period ending 5 minutes before the train departs for Boston. The departures were assigned to occur uniformly over a 15 minute period within the train to vehicle time being 2 to 4 minutes on average.

In Worcester the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:30 to 5:30 P.M. With the proposed commuter rail schedule the peak generator hours for the commuter rail station will be from 6:30 to 7:30 A.M. and from 6:00 to 7:00 P.M.

Once the project generated vehicles were distributed over time, the resulting hourly totals were assigned to the study area roadway system. Patrons who reside in Worcester would utilize a variety of travel routes depending on the location of their residence. Riders originating in towns outside the City of Worcester were assigned to the major routes leading from their town to the proposed station off of Shrewsbury Street.

Figure 1.2-10 shows the percentages of station related traffic utilizing the study are roadways for the 2001 "Build" condition.

Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

- The projected 2001 "No Build" traffic volumes
- Traffic specifically diverted to the proposed Worcester Commuter Rail Station.

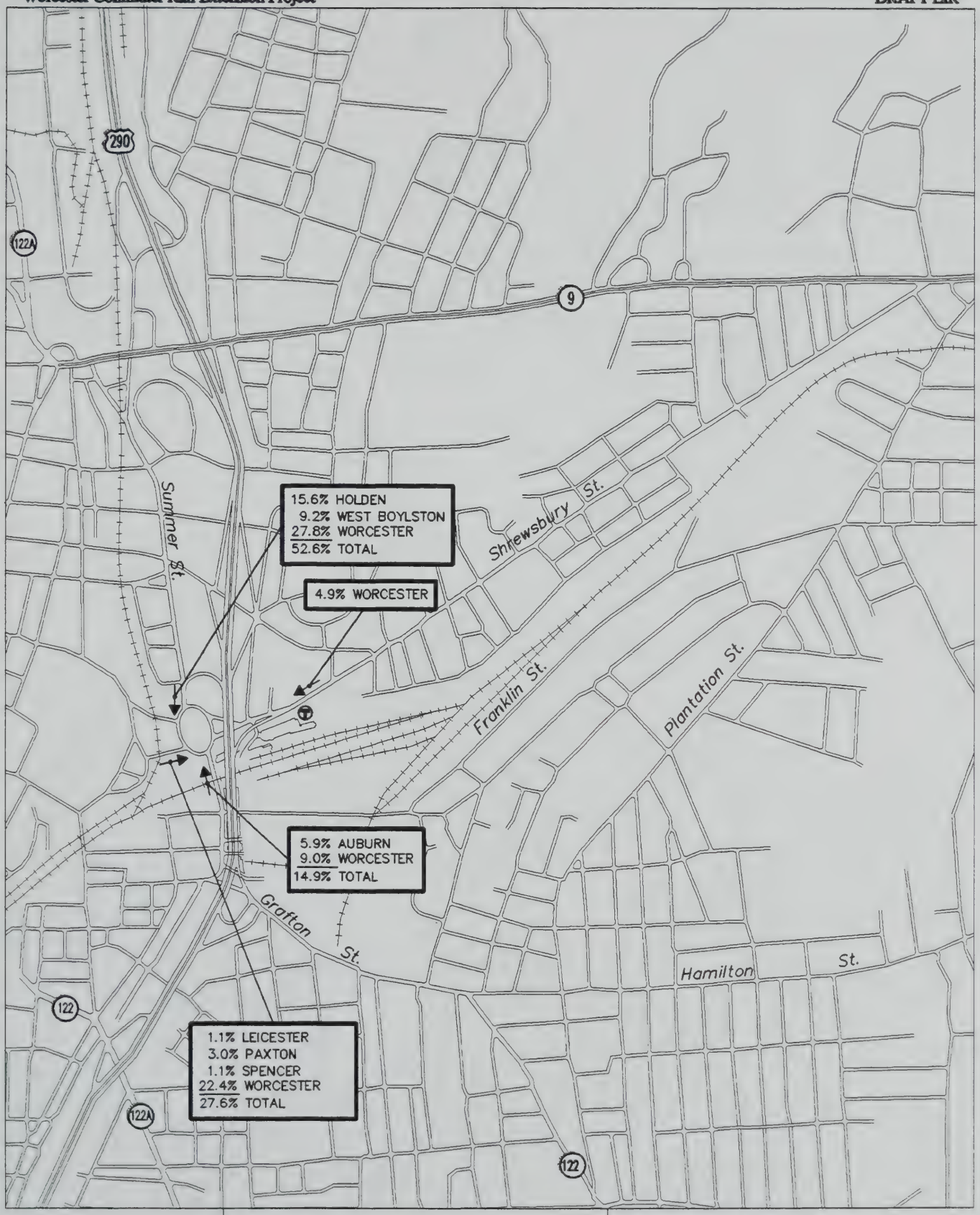
A portion of the traffic volumes heading to the proposed station will be diverted from traffic all ready on Shrewsbury Street. The vehicles currently using Shrewsbury Street who are diverted into the station are call by-pass traffic. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways, thus this analysis is a "worst case" analysis. Figures 1.2-11 and 1.2-12 show the A.M. and P.M. 2001 "Build" peak hour traffic volumes.

Year 2001 Peak Hour Level of Service Analysis

The same study area elements that were analyzed under the 1992 existing conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumption assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics remain unchanged unless noted.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 2001 "No Build" and "Build" conditions using the same methodology as with the existing conditions analysis. Results of the A.M. and P.M. peak hour analysis for the year 2001 "No Build" an "Build" conditions are listed in Table 1.2-8. Under the 2001 "No Build" conditions most of the intersection movements are at undesirable levels of service ratings. The access to the rotary from westbound Shrewsbury Street is of a level of service rating of "F" in both the A.M. and P.M. peak hours. The level of service rating



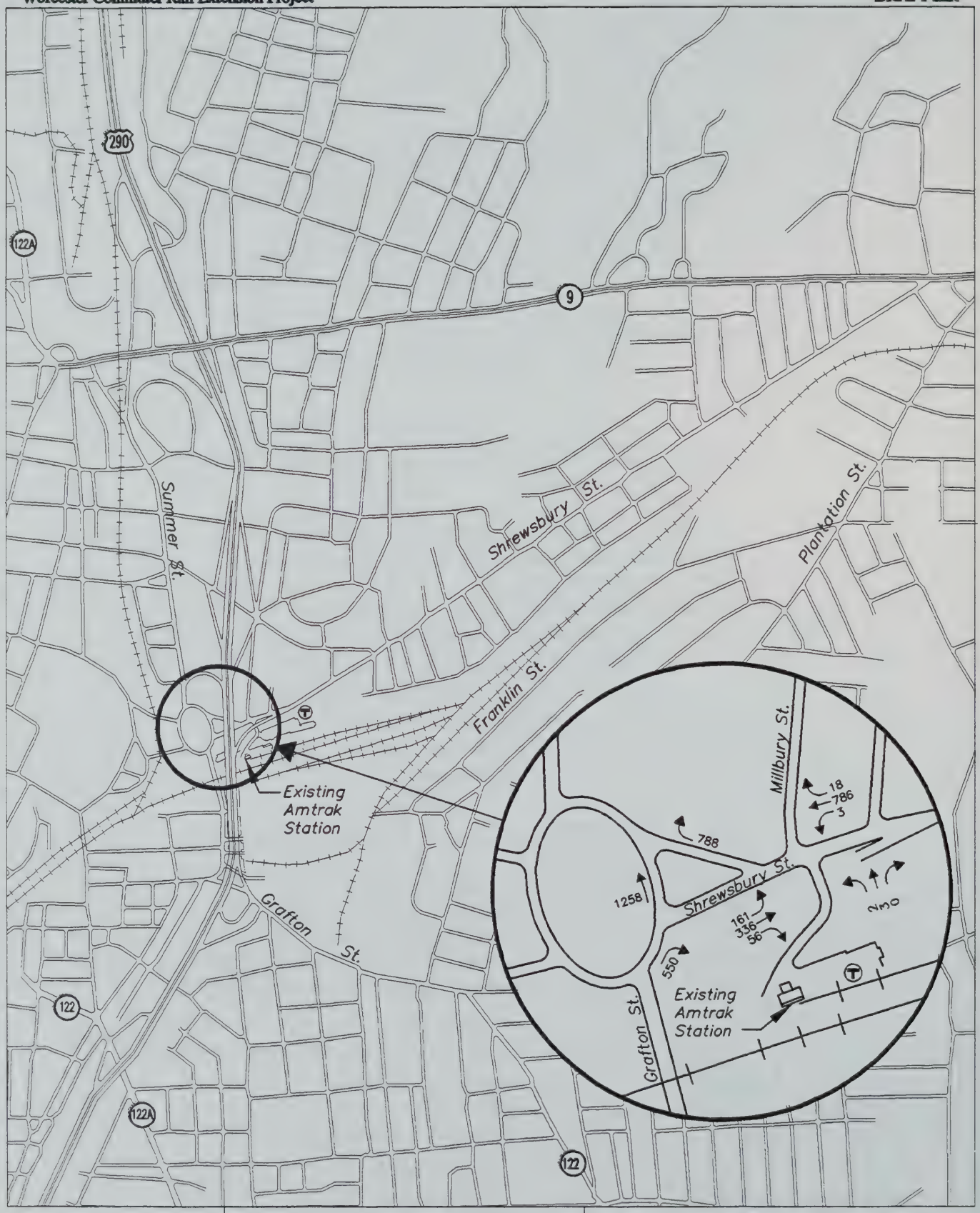
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±

0 1200

Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
INTRIM STATION, Worcester

FIGURE 1.2-10



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 BUILD ALL STATIONS
INTERIM STATION, Worcester

FIGURE 1.2-11

Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1200'±
0 1200

P.M. Peak Hour
4:30 - 5:30 P.M.
2001 BUILD ALL STATIONS
INTERIM STATION, Worcester

FIGURE 1.2-12

for the eastbound Shrewsbury Street traffic turning left to northbound Mulberry Street is "F" in the P.M. peak hour and the traffic exiting the site currently a city parking lot and Amtrak Station will have a level of service rating of "E" in the A.M. peak hour an a "F" in the P.M. peak hour.

Under the 2001 "Build" conditions the level of service rating don't change except for the P.M. peak hour level of service rating for the site's access to Shrewsbury Street, which improves to "E" from "F" because there is no appreciable traffic from the commuter rail station until after 5:35 P.M. when the first evening peak period train arrives from Boston.

Table 1.2-8 2001 Peak Hour Unsignalized Intersection Level of Service

Worcester	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Washington Square Rotary				
WB Shrewsbury Street	F(-463)	F(-561)	F(-465)	F(-561)
Shrewsbury with Site DW				
LT from EB Shrewsbury	C(244)	F(-193)	C(244)	F(-193)
LT from WB Shrewsbury	A(677)	A(536)	A(692)	A(563)
All from Site DW	E(45)	F(-54)	E(41)	E(20)

LOS (Reserve Capacity - Vehicles)

Year 2001 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes Table 1.2-9 lists the site generated traffic as a percentage of the total traffic within the study area. During the A.M. and P.M. peak hours.

As shown in Table 1.2-9 no intersections in the A.M. and P.M. peak hours will see ten percent or more of their traffic in the 2001 "Build" condition from the commuter rail station.

Table 1.2-9 2001 "Build" Condition Percentage of Traffic

Worcester	Peak Hours	
	A.M.	P.M.
Westbound Shrewsbury with the Washington Square Rotary	0.4%	0.0%
Shrewsbury with Site DW	6.4%	0.0%

Summary of Findings

The results of the LOS analysis indicate that no changes in levels of service at the intersections analyzed will occur due to construction of the Worcester Interim Station.

1.3 Millbury Station Route 122 Access Station

Project Introduction

The proposed Millbury Commuter Rail Station Alternative (accessed from Route 122) will be located in the northerly corner of the Town of Millbury, north of Route 122 and south of the railroad tracks. Access to the site will be gained from Route 122 at a point opposite the Mass Pike ramp terminus at Exit 11. The proposed site includes two industrial zoned parcels and one residentially zoned parcel.

This site was selected by both the MBTA and a citizen committee, established by the Millbury Board of Selectmen, after reviewing other potential sites. This location was chosen based on its potential parking capacity, availability of vacant land, proximity to major access roads, joint development potential and the minimal potential for environmental impacts.

The proposed station will consist of two 800 foot long low level platforms with a 45 foot long mini-high platform for handicapped access, a pedestrian overpass, a drop-off area for Kiss'n'Ride patrons, adequate lighting for public safety, and landscaping. A commuter parking lot of 300 spaces would be constructed in conjunction with the rail station. Access to the station's parking lot would be gained via a 1,200 foot long access road connected to Route 122 (Grafton Street).

Study Area

The study area for assessing the traffic impacts of this station focused on the roadways which are anticipated to be used as the major access routes. These roadways include:

- Grafton Street, State Route 122
- Southwest Cutoff, U.S. Route 20

Both of these roads are owned and maintained by the Massachusetts Highway Department.

Grafton Street, State Route 122, is a 40 foot wide two lane road. The Southwest Cutoff, U.S. Route 20, begins in the southwestern part of this study area as a 40 foot wide two lane road. Just west of Grafton Street, U.S. Route 20 becomes a four lane divided highway as it passes under Grafton Street and the Conrail Tracks. The four lane divided highway extends for approximately 1/4 of a mile before changing into a four lane, undivided highway, extending into the Town of Shrewsbury.

The intersections analyzed within the study area are controlled by stop signs or traffic signals.

Most of the commuters who are expected to use this station are believed to be currently accessing the Mass Pike at Exit 11 to travel to downtown Boston. Commuters from the towns of Charlton or Oxford who will use this station are believed to be accessing the Mass Pike at Exit 10 in Auburn.

Data Collection

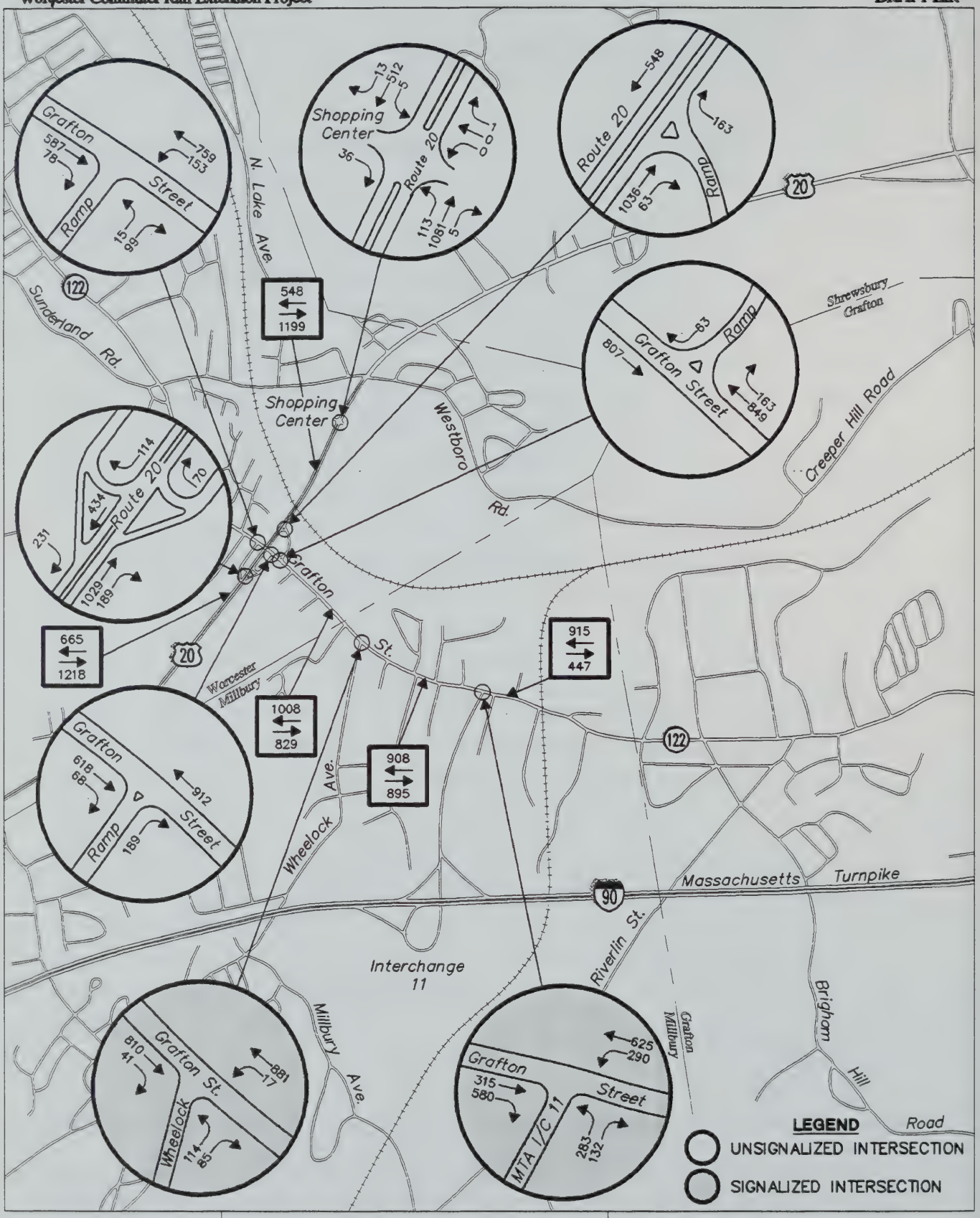
To assess the existing transportation environment, a traffic data collection program was performed from September of 1992 to May of 1993. Data items necessary for the operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing, and the geometric configuration of roadway links and intersections.

Intersection turning movement counts used for the existing conditions analysis, were performed at the following intersections on the dates indicated:

	A.M.	P.M.
Grafton Street with Exit 11 of the Mass Pike	05-11-93	05-11-93
Grafton Street with Wheelock Ave.	10-13-92	10-08-92
Northbound Grafton Street with the Ramp to Eastbound U.S. 20	05-19-93	05-19-93
Southbound Grafton Street with the Ramp to Eastbound U.S. 20	05-19-93	05-19-93
Grafton Road with the Ramp to Westbound U.S. 20	05-18-93	05-18-93
U.S. Route 20 with the Mall and driveway to businesses	11-19-93	09-01-92
Eastbound U.S. 20 with the Ramp to Southbound Grafton Street	05-19-93	05-19-93
Eastbound U.S. 20 with the Ramp to Northbound Grafton Street	05-19-93	05-19-93
Westbound U.S. 20 with the Ramp to Grafton Road	05-18-93	05-18-93

Vehicle turning movement counts were observed and recorded from 6:00 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the intersection peak hour volumes and the volumes during the projected commuter rail station peak generator hour.

Vehicles were classified into two categories: cars and trucks or busses. Volumes were recorded in the standard 15 minute intervals to allow for determination of the peak hour and calculation of the peak hour factor. The 1992 A.M. peak hour traffic volumes are shown in Figure 1.3-1, and the 1992 P.M. peak hour traffic volumes are shown in Figure 1.3-2. The 1992 A.M. peak generator hour traffic volumes are shown in Figure 1.3-3, and the 1992 P.M. peak generator hour traffic volumes are shown in Figure 1.3-4.



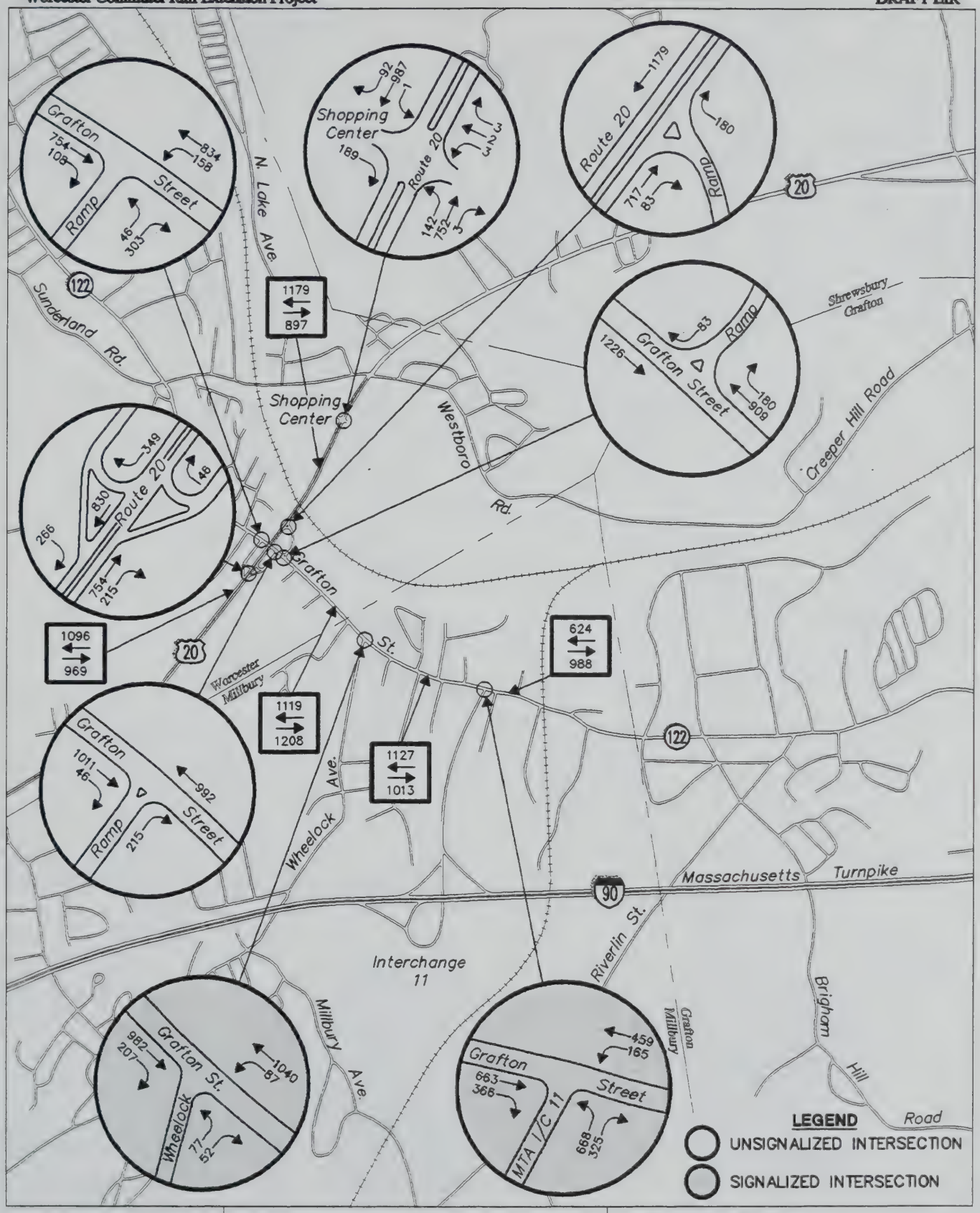
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:15 - 8:15 A.M.
1992 Existing Conditions
Millbury Station - Route 122

FIGURE 1.3-1



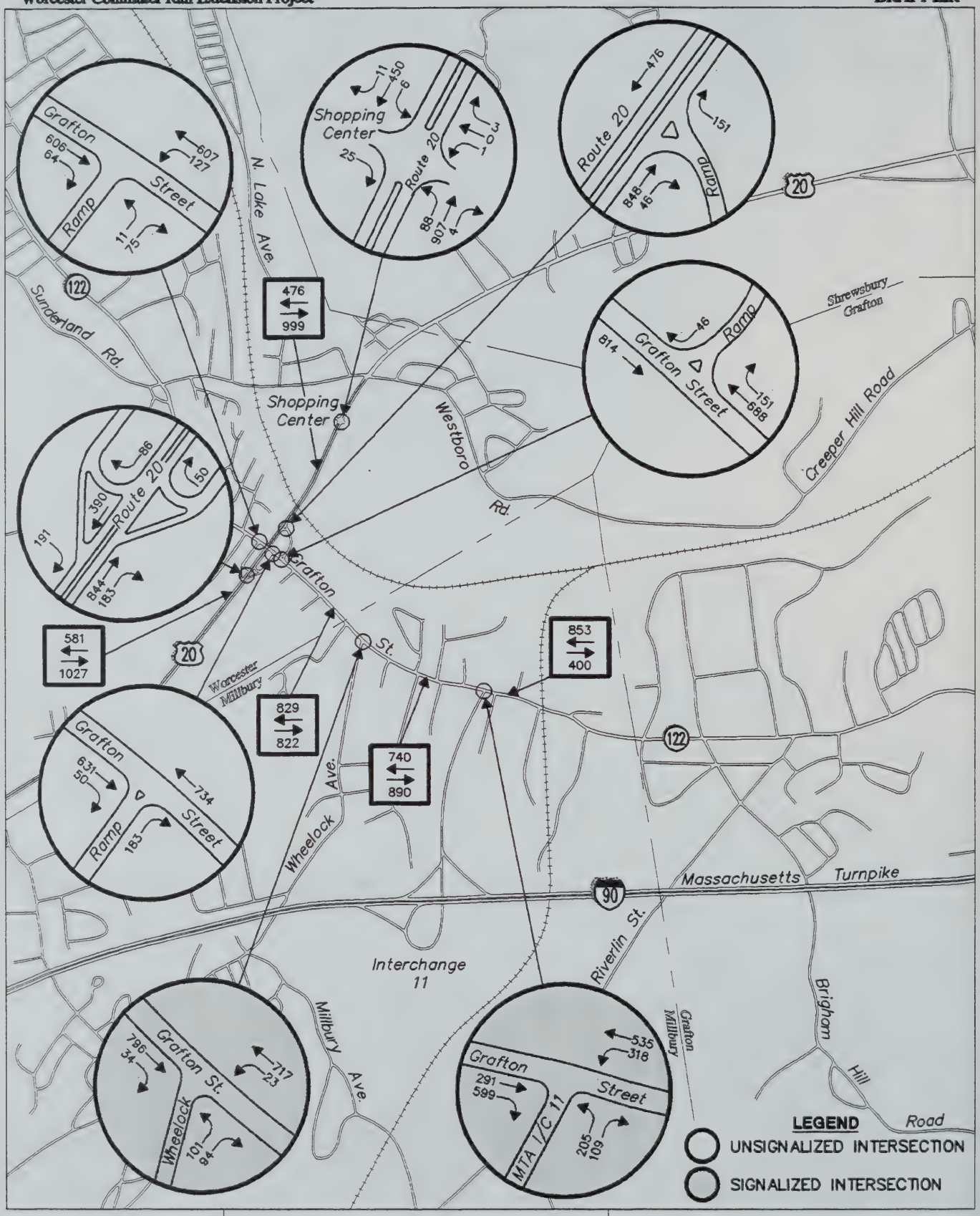
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1992 Existing Conditions
Millbury Station - Route 122

FIGURE 1.3-2



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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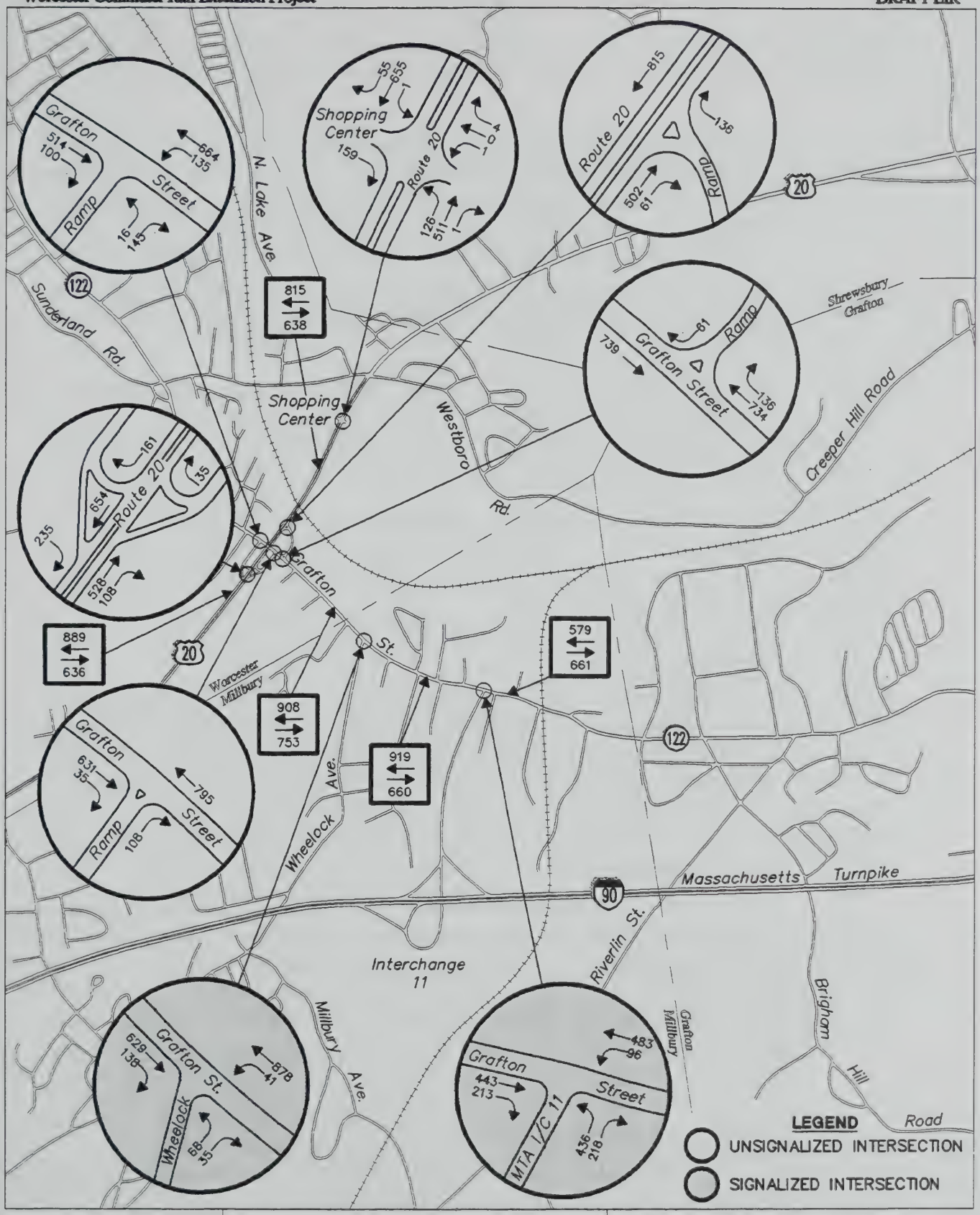
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1992 Existing Conditions
Millbury Station - Route 122

FIGURE 1.3-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1992 Existing Conditions
Millbury Station - Route 122

FIGURE 1.3-4

Traffic signal phasing and timings are typically required for the analysis of signalized intersection operations. The existing traffic signals within the study area are traffic actuated. The phasing patterns were observed in the field. The current signal timings were not obtained from the Massachusetts Highway Department (MHD), instead the optimization routine of "CINCH" was used to estimate the existing or future conditions. This was done because the districts within the MHD have personnel assigned to change the traffic signal timings of the signals that they own and maintain to fit the current traffic patterns.

Intersection geometric configurations were determined through field observations. Geometric elements such as number and use of travel or intersection lanes, lane widths, and roadway grades which are required for operational analysis were field measured or estimated.

The field data sheets for the counts are available for review at the MBTA or MEPA Office.

Year 1992 Existing Conditions

Signalized Intersections

The existing signalized intersections were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The micro-computer software program "CINCH", developed by the Central Transportation Planning Staff (CTPS) was used for the intersection analysis. This program automates the analysis procedures of the HCM.

Grafton Street with Exit 11

The intersection of Grafton Street With Exit 11 is a "T" intersection. The intersection is controlled by a two phase traffic actuated signal. The traffic turning right from southbound Grafton Street to the Turnpike or turning right from the Turnpike to southbound Grafton Street have what is termed as a free right turn, that is the right turning traffic uses a lane separated from the intersection by a fairly large traffic island and the movement is not controlled by the traffic signals. Since the right turning volumes are not controlled by the traffic signal they are not included in the analysis.

Grafton Street with Wheelock Avenue

The intersection of Grafton Street with Wheelock Avenue is a "T" type intersection. The intersection is controlled by a two phase traffic actuated signal.

Table 1.3-1 list the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours. As shown in the table, both the Grafton Street/Exit 11 intersection and the Grafton Street/Wheelock Avenue intersections are operating at acceptable overall peak hour levels of service. The northbound approach from the Exit 11 ramp is at LOS "E" in the P.M. peak hour.

Table 1.3-1 1992 Existing Signalized Intersection Level of Service

Millbury (Route 122)	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(5.8)	D(33.2)	B(5.2)	B(9.8)
Eastbound	A(3.2)	C(15.7)	A(3.2)	B(9.5)
Westbound	A(4.9)	C(21.6)	A(4.8)	B(9.6)
Northbound	B(10.9)	E(59.5)	B(9.2)	B(10.3)
Route 122 and Wheelock**	A(4.0)	B(6.0)	A(4.0)	A(2.6)
Eastbound	A(3.0)	A(2.4)	A(3.1)	A(1.8)
Westbound	A(3.3)	B(8.4)	A(3.2)	A(2.2)
Northbound	B(11.4)	B(14.3)	B(11.2)	B(13.4)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Analysis was also performed for the peak generator hours, the A.M. or P.M. hour when the highest traffic volumes are entering or exiting the site. A detailed discussion of the determination of the peak generator hours is contained in the Trip Distribution And Assignment Section of this report.

The results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.3-1. As shown in the table, both the Grafton Street/Exit 11 intersection and the Grafton Street/Wheelock Avenue intersection are operating at acceptable overall peak generator hour levels of service as are all of the individual directional movements.

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The micro-computer software program "CINCH" was used to perform the analysis. As with the signalized intersections, the A.M. and P.M. peak hours and peak generator hours were analyzed.

As opposed to signalized intersection results, the level of service rating for unsignalized intersections are stated in terms of reserve capacity. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. Another important difference between signalized and unsignalized analysis is there is no overall rating for unsignalized intersections. A detailed description of level of service is provided in Section 1.1 of this report.

Grafton Street with the Westbound Route 20 Ramp

The Ramp from or to Route 20 westbound intersects the southbound side of Grafton Street at 90 degrees forming a "T" intersection. The traffic from westbound Route 20 is controlled from turning left or right onto Grafton Street by a stop sign.

Grafton Street Southbound with the Eastbound Route 20 Ramp

The Ramp from or to Route 20 eastbound intersects the southbound side of Grafton Street at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the southbound through movement, the eastbound right turn movement from Grafton Street, and the southbound right turn movement from Route 20. The eastbound right turn movement is controlled by a stop sign.

Grafton Street Northbound with the Eastbound Route 20 Ramp

The Ramp from or to Route 20 eastbound intersects the northbound side of Grafton Street at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the northbound through movement, the eastbound right turn movement from Grafton Street, and the northbound right turn movement from eastbound Route 20. The northbound right turn movement is controlled by a stop sign.

Route 20 Westbound to or from the Grafton Street Ramp

The ramp to or from Grafton Street intersects the westbound side of Route 20 at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the westbound through movement, the right turn movement from Route 20, and the westbound right turn movement from Grafton Street. The westbound right turn movement is controlled by a stop sign.

Route 20 Eastbound to or from the Southbound Grafton Street Ramp

The ramp to or from Southbound Grafton Street intersects the eastbound side of Route 20 at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the eastbound through movement, the southbound right turn movement from Grafton Street, and the eastbound right turn movement from Southbound Grafton Street. The eastbound right turn movement is controlled by a stop sign.

Route 20 Eastbound to or from the Northbound Grafton Street Ramp

The ramp to or from Northbound Grafton Street intersects the eastbound side of Route 20 at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the eastbound through movement, the right turn movement from Route 20, and the eastbound right turn movement from northbound Grafton Street. The eastbound right turn movement is controlled by a stop sign.

Route 20 with the Mall and Truck Business Driveways

Route 20 intersects the driveways to the Mall and the Truck Business at a 90 degree angle forming a cross road intersection. There are left turning lanes and two through lanes for the eastbound or westbound Route 20 traffic. There is also right turning deceleration lane to access the Mall and a right turning acceleration lane for access to Route 20 from the Mall. Access from the Mall to Route 20 is limited to a right turn only onto westbound Route 20 and is controlled by a stop sign. Access to Route 20 from the Truck Business is uncontrolled but exiting traffic behaved as if it was stop sign controlled.

The results of the A.M. and P.M. peak hour analysis of the unsignalized intersections are found in Table 1.3-2. As shown in the table, most of the analyzed intersection movements are operating at acceptable level of service ratings.

Table 1.3-2 1992 Unsignalized Intersection Level of Service

Millbury (Route 122)	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(383)	C(262)	A(407)	A(439)
LT and RT from Ramp	E(77)	F(-236)	D(159)	D(136)
SB Grafton and Route 20 East				
RT from Ramp	C(299)	E(80)	B(304)	B(394)
NB Grafton and Route 20 East				
RT from Ramp	C(280)	C(229)	B(380)	B(352)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(499)	C(217)	A(574)	B(381)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(423)	A(489)	A(488)	A(661)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(345)	A(415)	A(432)	A(561)
Route 20 and Mall				
LT from EB Route 20	A(422)	D(132)	A(489)	B(313)
LT from WB Route 20	C(235)	B(388)	B(305)	A(541)
All from Truck Business	A(456)	F(-2)	D(113)	D(111)
RT from Mall	A(646)	B(300)	A(684)	A(461)

LOS (Reserve Capacity - Vehicles)

The traffic turning left or right from WB Route 20 to Grafton St. in the A.M. peak hour is LOS "E". The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour is LOS "F". The traffic turning right from EB Route 20 to SB Grafton St. in the P.M. peak hour is LOS "E".

The results of the A.M. and P.M. peak generator hour analysis of the unsignalized intersections are also listed in Table 1.3-2. As shown in the table, all of the intersection movements analyzed are operating at acceptable level of service ratings.

Roadway Segments

The average daily traffic (ADT) and average weekday traffic (AWDT) are shown on Figure 1.3-5. The existing roadway segments were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The micro-computer software program "Highway Capacity Software (HCS)" version 1.5 was used to perform the analysis. As with the signalized and unsignalized intersections, the A.M. and P.M. peak hours and peak generator hours were analyzed.

The results of the A.M. and P.M. peak hour analysis of the roadway segments are found in Table 1.3-3. As shown in the table many of the analyzed roadway segments are operating at the level of service rating of "E". However, all but four of the segments analyzed operate within the acceptable range of reserve capacity (greater than 600 vehicles). The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

- Route 122 North of Exit 11 in the P.M. peak hour
- Route 122 North of Wheelock in the P.M. peak hour
- Route 20 West of Grafton St. in the A.M. and P.M. peak hours

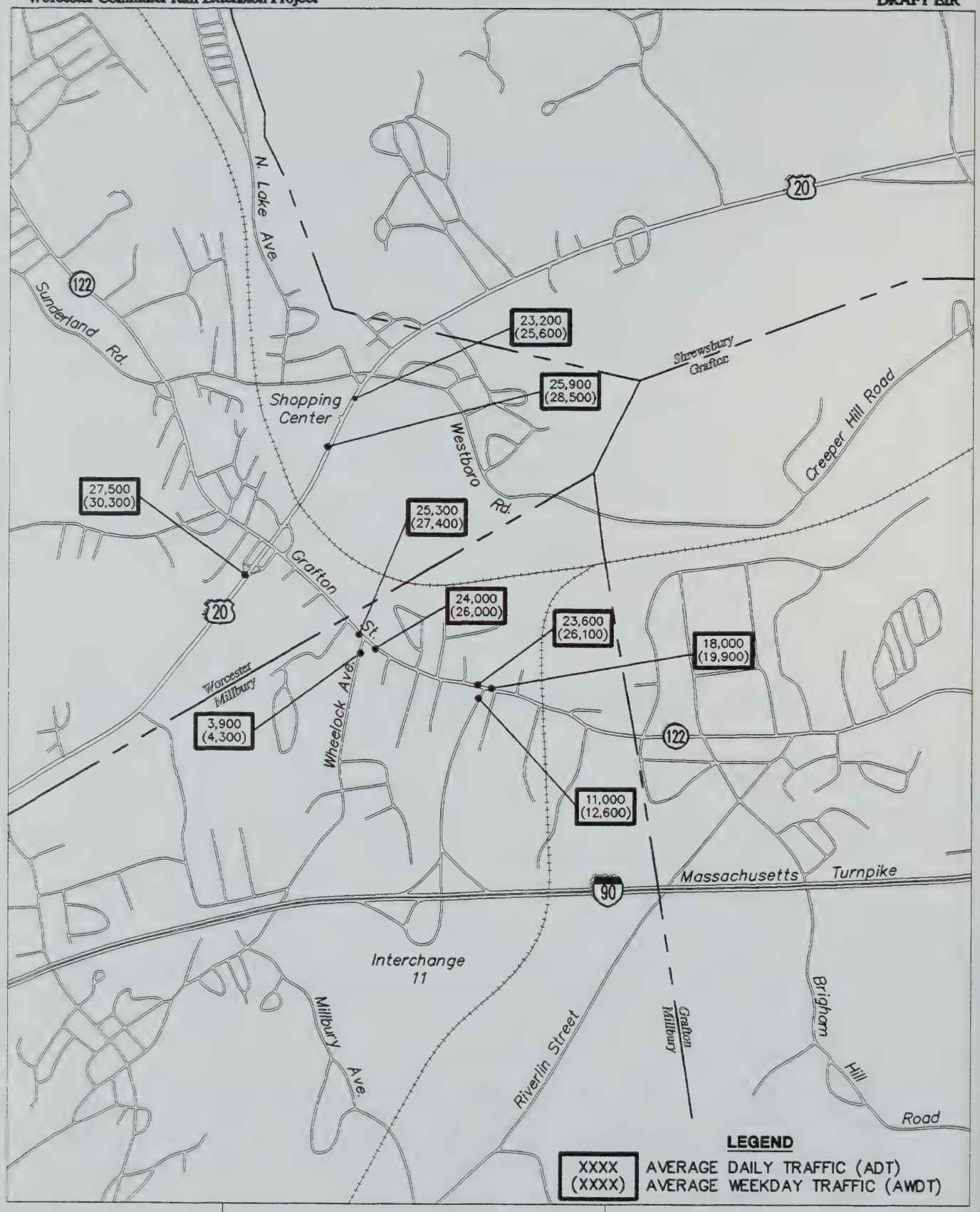
Table 1.3-3 1992 Existing Road Segment Level of Service

Millbury (Route 122)	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(964)	E(845)	D(1067)	D(1377)
Route 122 North of Exit 11	E(744)	E(441)	E(846)	E(926)
Route 122 North of Wheelock	E(628)	E(262)	E(904)	E(889)
Route 20 West of Route 122	E(417)	E(450)	E(587)	E(886)
EB Route 20 West of Mall	B(2042)	A(2425)	A(2224)	A(2552)
WB Route 20 West of Mall	A(2496)	B(2177)	A(2499)	A(2445)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Safety Concerns And Accident History

The Millbury Police Department was contacted on June 21, 1994 to determine the existence and location of any safety concerns or high accident intersections. Chief Handfield indicated that no existing serious safety concerns or high accident locations currently exist within the MBTA study area. Preliminary analysis of accident data supplied by the Department supports this conclusion.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

1992 Average Daily Traffic and 1992 Average Weekday Traffic Millbury, MA - Route 122

FIGURE 1.3-5

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, the year 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments within the study area.
- Increases in existing traffic volumes due to population growth and development within the vicinity of, but outside of the study area.

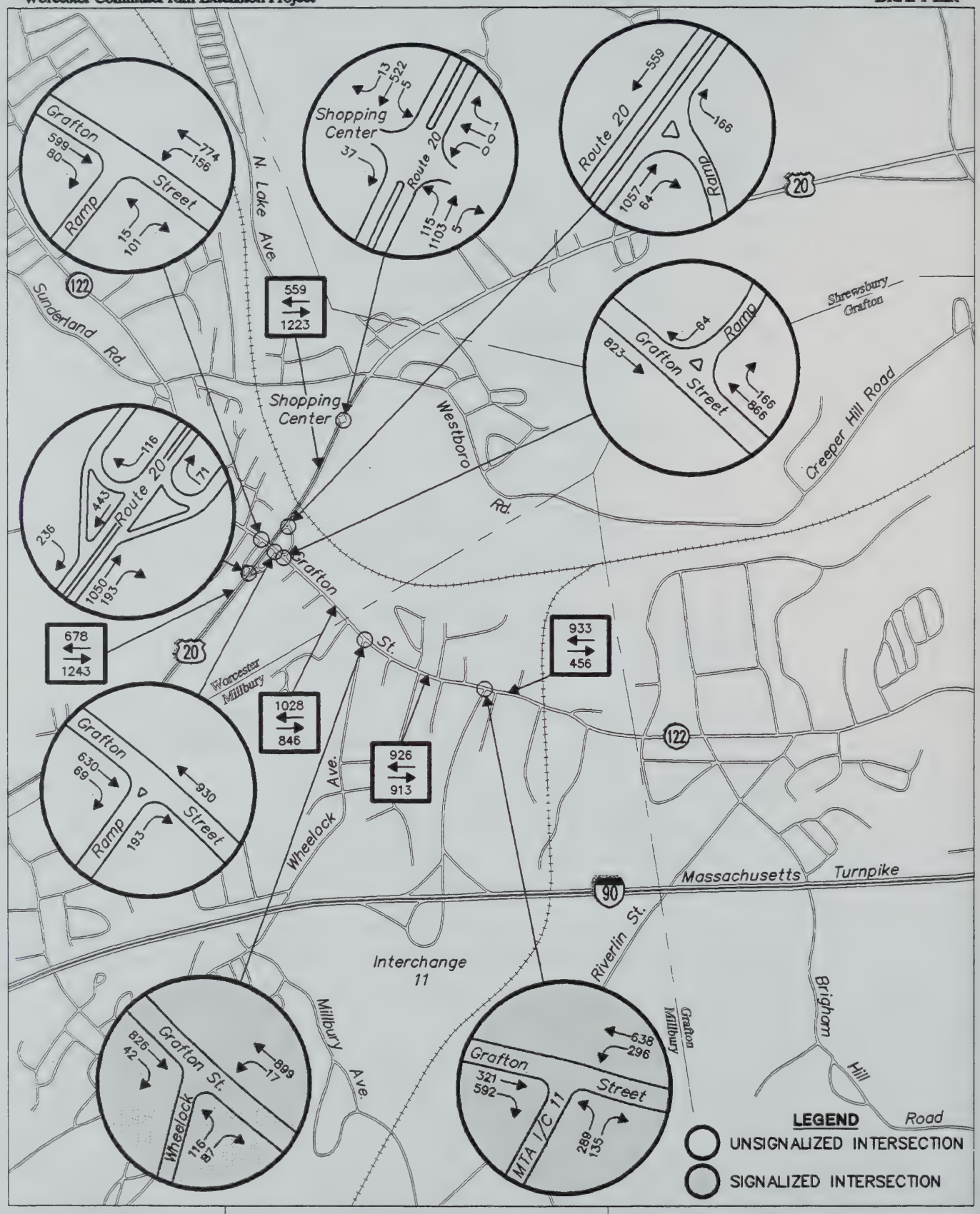
Through discussions with the Town of Millbury, it was determined that no major new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of the 1996 "No Build" traffic volumes.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. The Massachusetts Highway Department compiles and publishes traffic volume data, through a statewide traffic counting program. One count site in Millbury is published in the state's traffic volume data. The site on Route 122 experienced a growth rate of negative 0.1 percent over the last few years. The trend station for this area is located on Route 9. The data from this station showed an average growth rate of negative 1.1 percent over the last 3 years.

This negative growth rate is most likely due to the economic downturn experienced throughout the region over the past years. Economic indicators point towards a very slow recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

To account for this potentially low growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5 percent per year was applied to the 1992 Existing condition traffic volumes to obtain the 1996 "No Build" traffic volumes.

Figure 1.3-6 shows the projected A.M. peak hour traffic volumes, and Figure 1.3-7 shows the projected P.M. peak hour traffic volumes. Figure 1.3-8 shows the projected A.M. peak generator hour traffic volumes, and Figure 1.3-9 shows the projected P.M. peak generator hour traffic volumes.

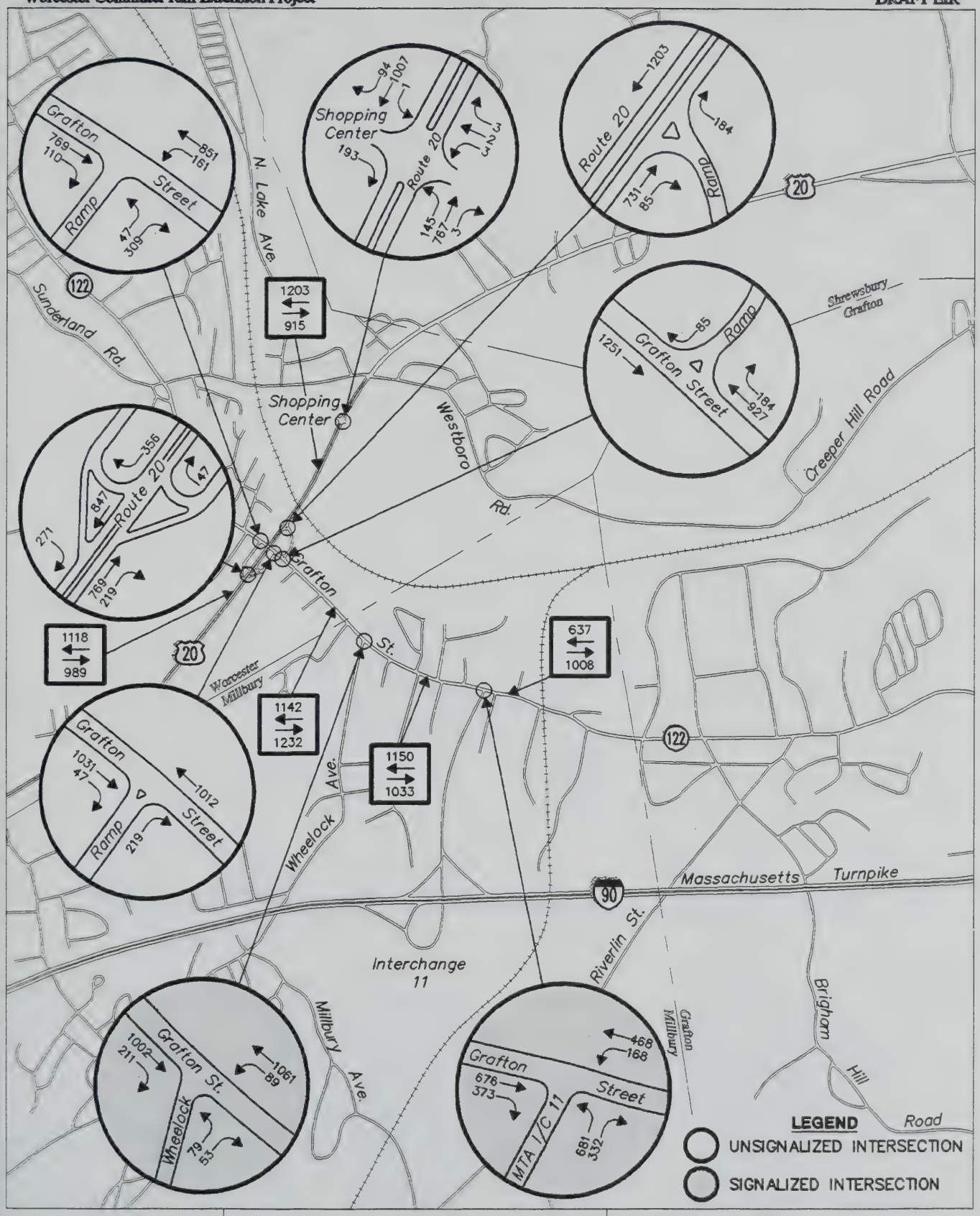


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

A.M. Peak Hour
7:15 - 8:15 A.M.
1996 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-6



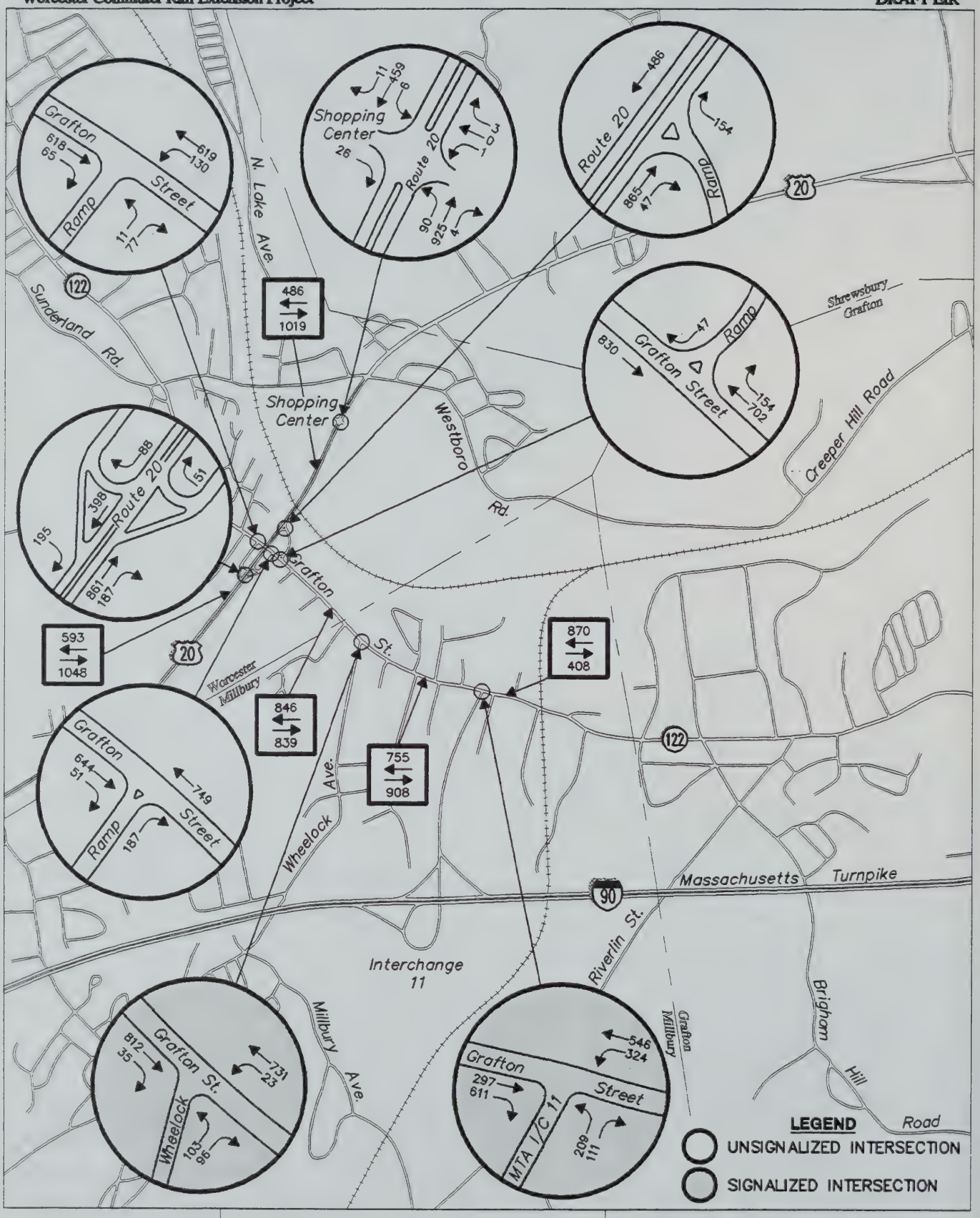
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-7

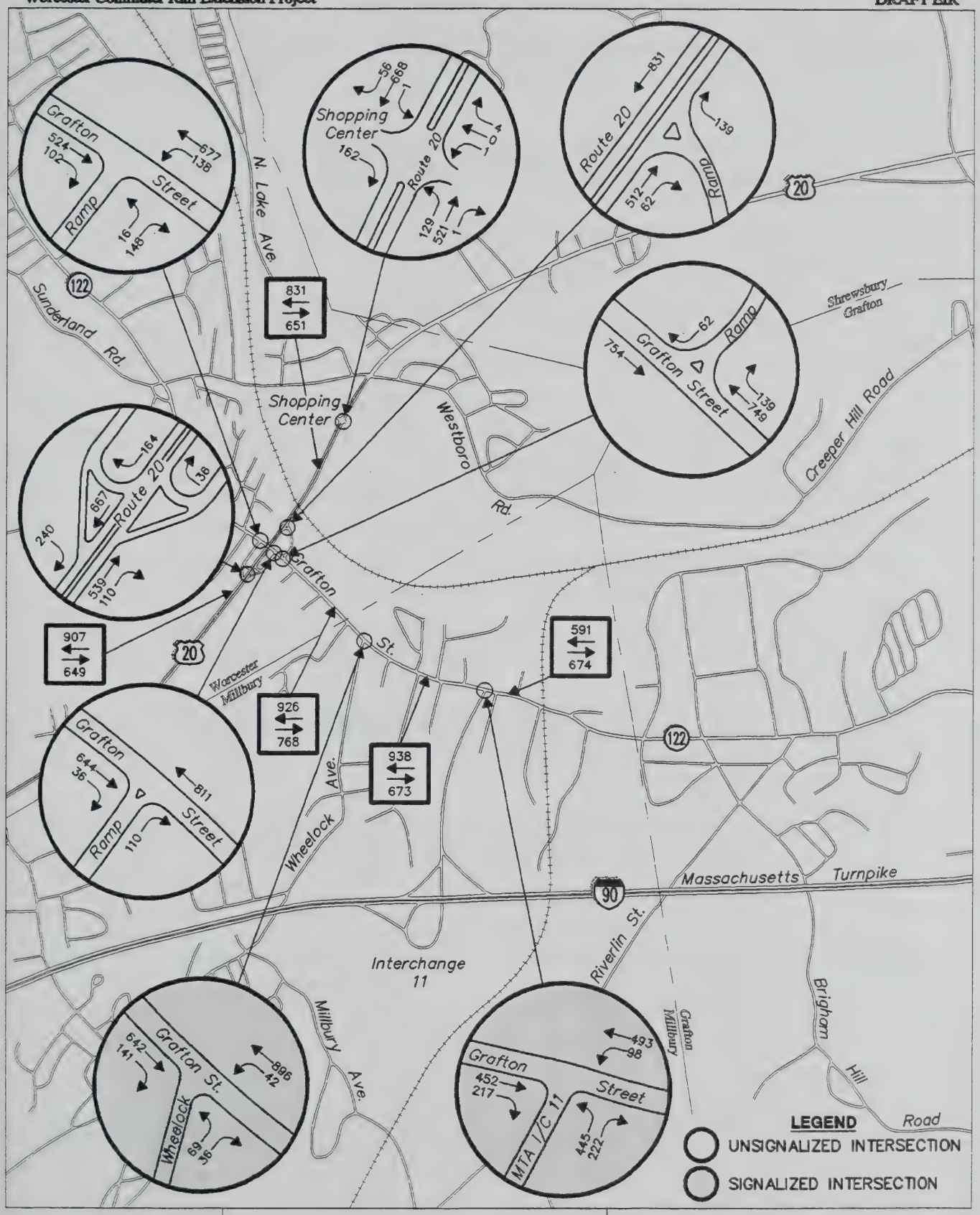


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-8



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1996 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-9

The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to Worcester.

Year 1996 Trip Generation And Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 commuters are expected to utilize the railroad for daily round trip commuting into Boston.

In 1996, the proposed Millbury Station is projected to attract a total of 149 daily round trip commuters. Twelve of these patrons would be dropped off at the station. Based upon an average automobile occupancy rate of 1.12, the remaining 137 patrons would result in a parking demand of 122 parking spaces. This leaves 178 parking spaces empty in the build year.

The patrons who are projected to use the Millbury Station are expected to reside in the Towns of Auburn, Charlton, Millbury, Oxford, and the City of Worcester. The number of patrons who originate from each Town are shown in Table 1.3-4. The ridership has been adjusted to reflect peak period usage, which is 94% of the total daily demand.

These ridership levels are expected to occur shortly after completion of the Millbury Station, therefore, these projections were used in the determination of the 1996 "Build" condition.

Table 1.3-4 Projected Patrons of Millbury Station - Year 1996

Town	Riders*
Auburn	25
Charlton	16
Millbury	24
Oxford	16
Worcester	58
TOTAL	**139**

* *Adjusted for peak period demand*

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the usual starts of the business day (7:30, 8:00, 8:30, or 9:00) will be more in demand than trains which arrive either earlier or later.Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the usual close of business (4:30, 5:00, 5:30, or 6:00 P.M.) are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on current ridership per train and the arrival or departure times in Boston of said trains. Details of the development of these equations are presented in Section 1.1 of this Appendix.

Table 1.3-5 lists the projected distribution of ridership from the Millbury Station based on the expected arrival time in Boston or departure time from Boston.

Table 1.3-5 MBTA Ridership Distribution

Inbound Train	Patrons
502A	27
504A	45
506A	45
510	22
TOTAL	**139**
Outbound Train	**Patrons**
515A	19
519	32
521	32
521A	49
523	7
TOTAL	**139**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the out of pocket cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time typically results in the A.M. and P.M. peak hours for the site to lie totally or partially outside of the typical peak hour ranges of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

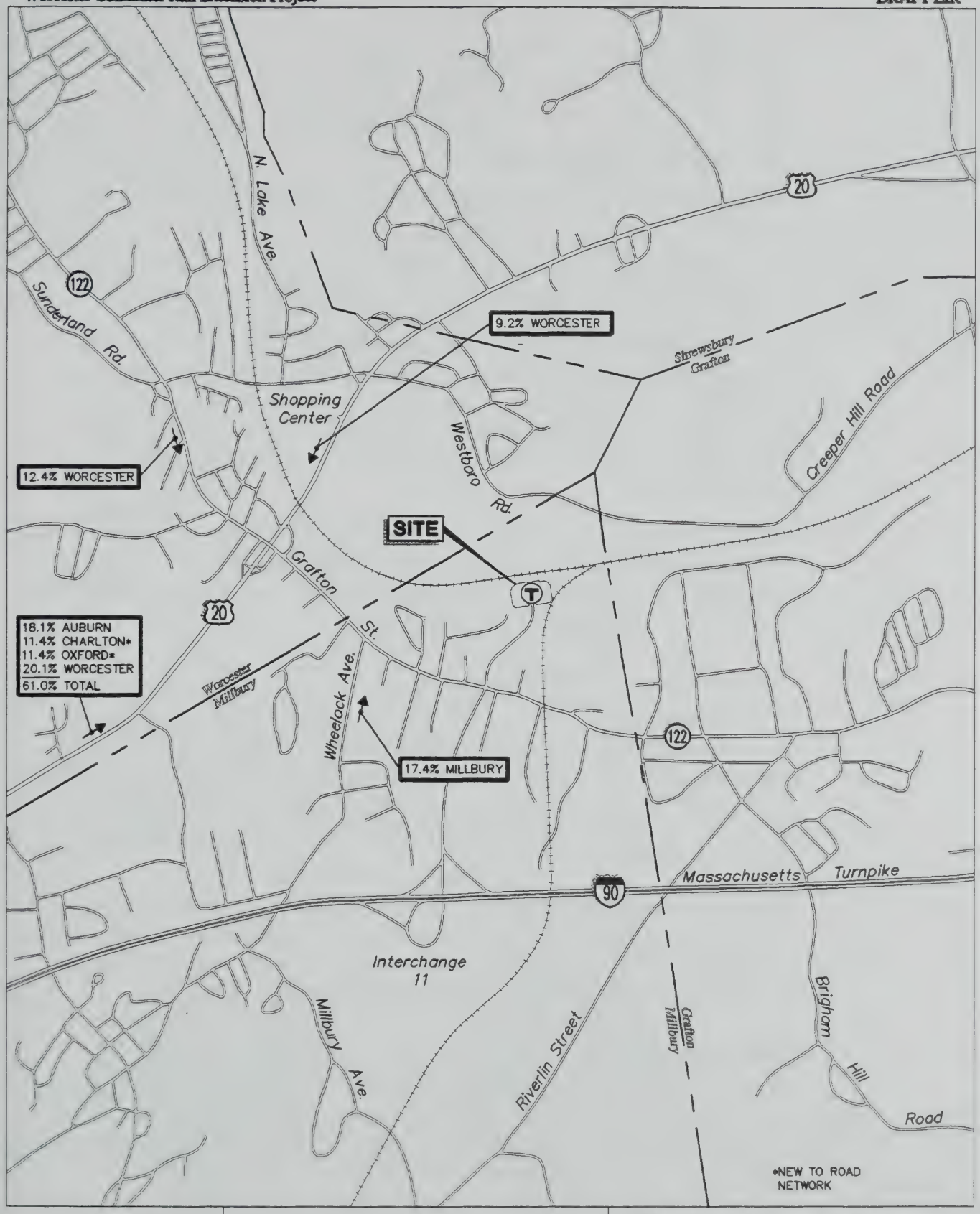
The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Millbury Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Millbury the typical A.M. and P.M. intersection peak hours are from 7:15 to 8:15 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 6:00 to 7:00 P.M.

Once the project generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Millbury would utilize eastbound Route 20 or northbound Wheelock Avenue, depending on the location of their residences. Riders originating in towns outside that which the station is located were assigned to the major roads from their town to the station.

The patrons from Auburn, Charlton, and Oxford would access the station from eastbound U.S. Route 20. The patrons from Worcester would access the station from eastbound Route 20, westbound Route 20, or southbound Route 122. Actual routing was estimated based on the shortest travel time and distance from population centers. Figure 1.3-10 shows the percentage of station related traffic utilizing the study area roadways for the year 1996 "Build" condition.

Upon completion of the commuter rail service, commuters will shift from automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along the Mass Pike. Traffic volumes are expected to increase on Route 20 west of Route 122.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-10

Year 1996 "Build" Traffic Volumes

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Millbury rail station.

A portion of the traffic volumes heading to the proposed station would be diverted from the existing travel route to the Mass Pike, (travel route being Grafton Street, Route 122). These existing vehicle trips would not be generated as new trips. The vehicles currently by-passing the site were not assigned to the roadway network as new trips, they are only shown as being diverted from the Mass Pike to the commuter rail site.

Figure 1.3-11 shows the projected A.M. peak hour traffic volumes. Figure 1.3-12 shows the projected P.M. peak hour traffic volumes. Figure 1.3-13 shows the projected A.M. peak generator hour traffic volumes. Figure 1.3-14 shows the projected P.M. peak generator hour traffic volumes.

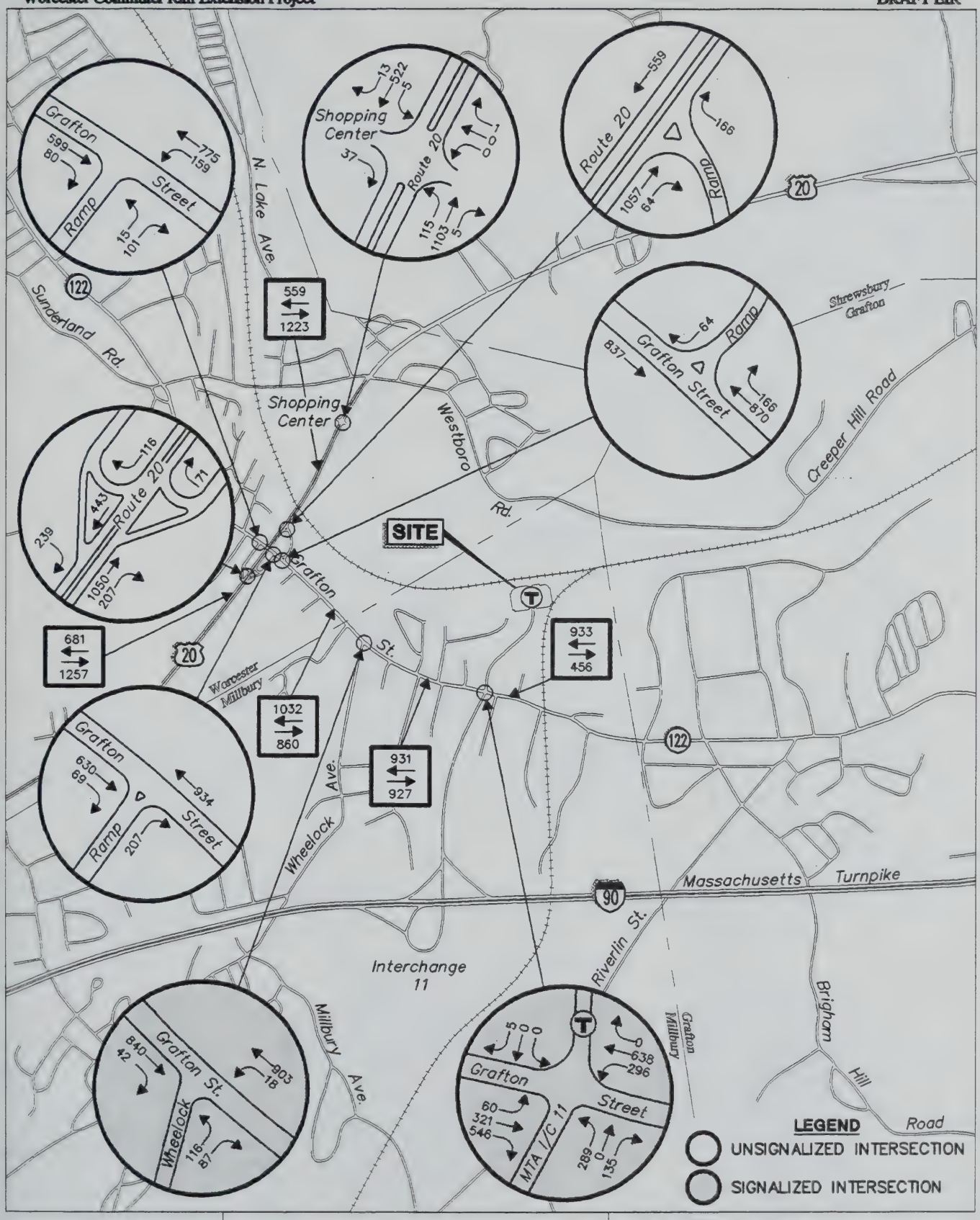
Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only major parameter in the analysis to change from the existing conditions. Roadway geometries, signal phasing, percentages of heavy vehicles, etc. remain unchanged.

The traffic signal timings for the 1996 "No Build" condition and for the 1996 "Build" condition were optimized. Normal maintenance of traffic signals includes the recounting of intersection traffic volumes and the retiming of the traffic signals to account for changes in traffic volumes and travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-6 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.



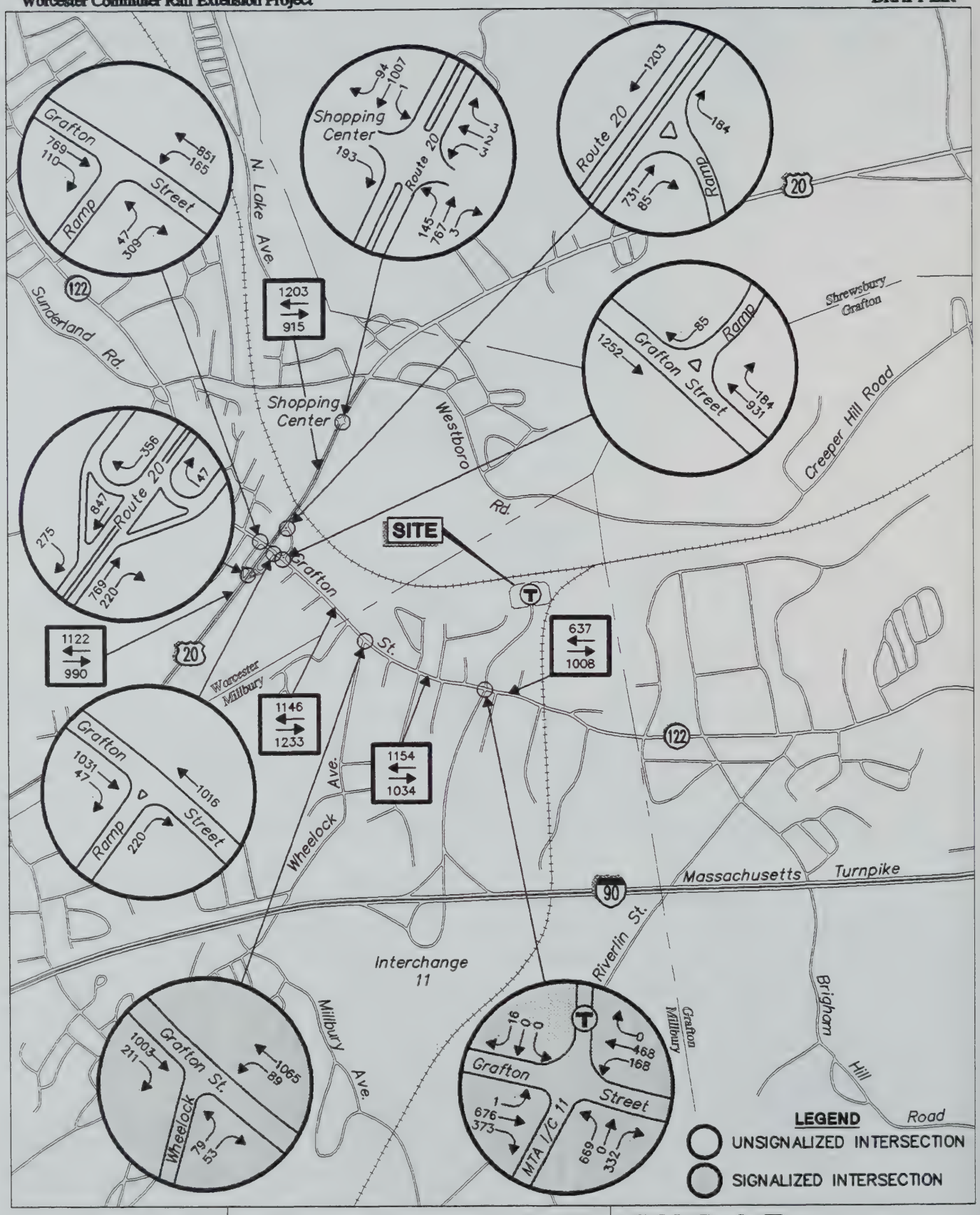
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M Peak Hour
7:15 - 8:15 A.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-11

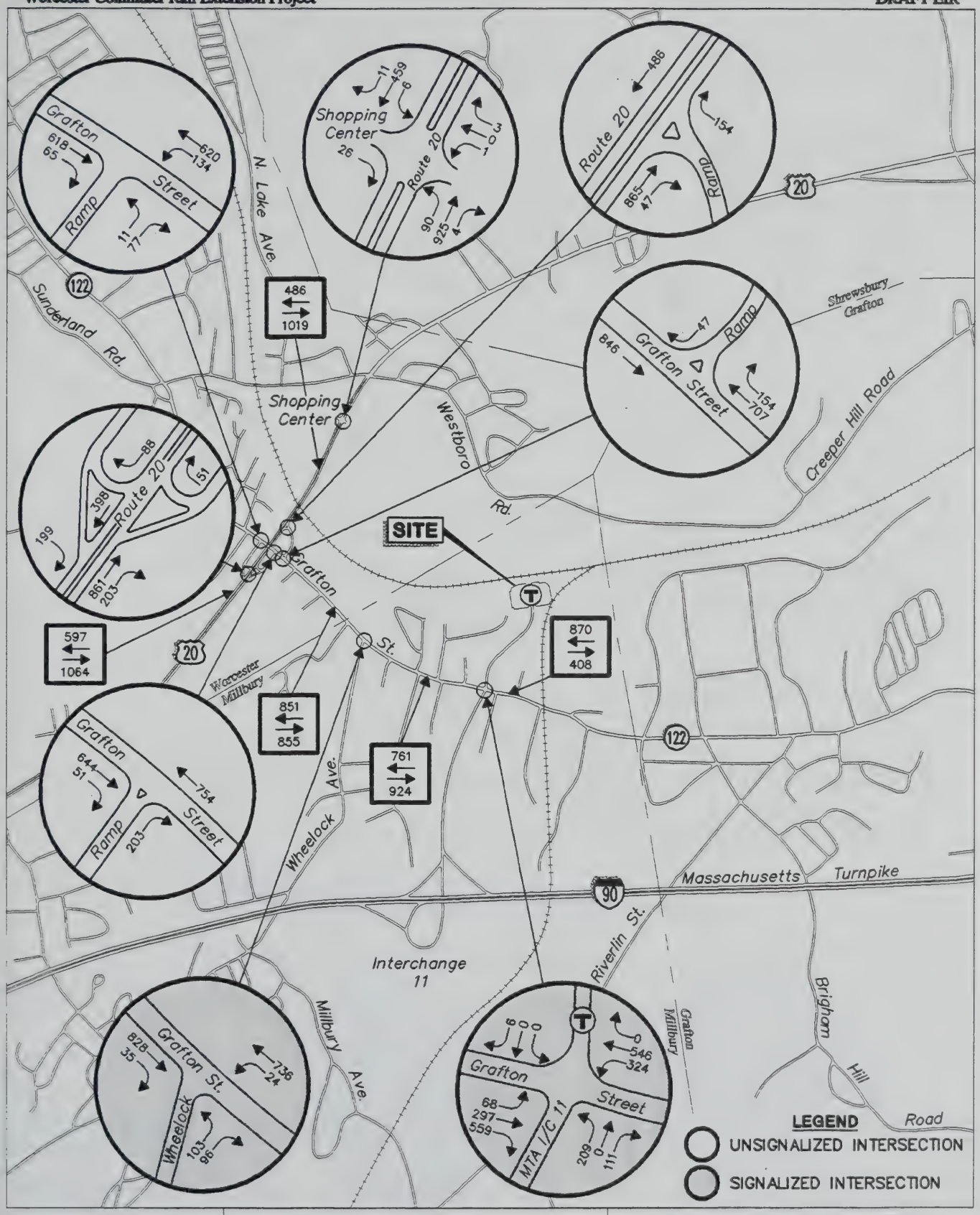


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-12



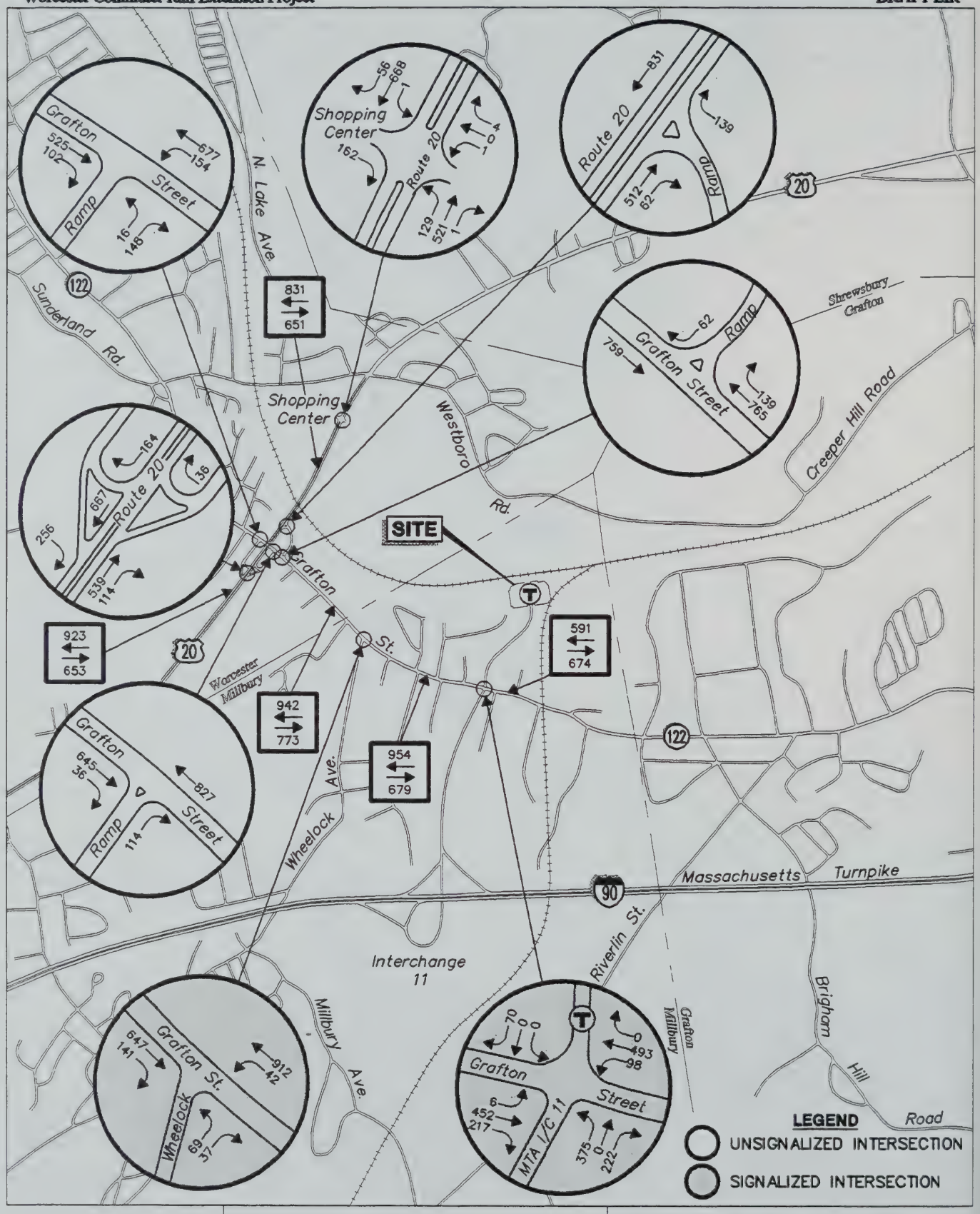
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-14

Under the 1996 "No Build" conditions both existing intersections will operate at overall acceptable level of service ratings. The northbound movement from the Mass Pike will function at LOS "E" in the P.M. peak hour.Under the 1996 "Build" condition both intersections are expected to operate at acceptable level of service ratings. The Grafton Street/Exit 11 intersection is expected to operate at LOS "E" during the P.M. peak hour. The eastbound movement from Grafton Street at Exit 11 and the southbound movement from the proposed site driveway will operate at LOS "E" during the P.M. peak hour, while the northbound movement from Exit 11 will operate at LOS "F" during the P.M. peak hour.

The overall P.M. peak hour Level of Service at the Grafton Street/Exit 11 intersection is anticipated to change from LOS "D" under "No Build" conditions to LOS "E" under "Build" conditions.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-7 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

As shown in the table, the analyzed intersection movements in the "No Build" condition are generally operating at acceptable level of service ratings.

- Traffic from WB Route 20 to Grafton Street operates at LOS "E" in the A.M. peak hour.
- Traffic from EB Route 20 to SB Grafton Street functions at LOS "E" in the P.M. peak hour.

The following movements operate at unacceptable LOS "F":

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.
- All the NB traffic from the Truck Business in the P.M. peak hour.

Table 1.3-6 1996 Peak Hour Signalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(5.4)	D(34.6)	B(10.4)	E(49.9)
Eastbound	A(2.6)	C(15.1)	B(5.6)	E(55.1)
Westbound	A(4.4)	D(26.7)	B(8.8)	D(33.8)
Northbound	B(11.2)	E(59.6)	C(21.5)	F(60.0)
Southbound	-	-	C(16.4)	E(43.3)
Route 122 and Wheelock**	A(2.6)	B(6.0)	A(2.8)	B(6.1)
Eastbound	A(2.0)	A(1.4)	A(2.0)	A(1.4)
Westbound	A(2.1)	B(6.3)	A(2.2)	B(6.4)
Northbound	B(10.2)	D(34.5)	B(9.2)	D(36.5)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Table 1.3-7 1996 Peak Hour Unsignalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 122 West				
LT from NB Grafton	B(371)	C(250)	B(368)	C(246)
LT and RT from Ramp	E(66)	F(-253)	E(64)	F(-255)
SB Grafton and Route 20 East				
RT from Ramp	C(287)	E(68)	C(272)	E(67)
NB Grafton and Route 20 East				
RT from Ramp	C(270)	C(218)	C(268)	C(216)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(488)	C(204)	A(485)	D(200)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	B(393)	A(507)	B(389)	A(506)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(334)	A(433)	B(334)	A(433)
Route 20 and Mall				
LT from EB Route 20	A(413)	D(121)	A(413)	D(121)
LT from WB Route 20	C(227)	B(380)	C(227)	B(380)
All from Truck Business	A(448)	F(-4)	A(448)	F(-4)
RT from Mall	A(641)	C(289)	A(641)	C(289)

LOS (Reverse Capacity - Vehicles)

As shown in the table most of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings with the following exceptions: As in the "No Build" condition traffic from WB Route 20 to Grafton Street in the A.M. peak hour and traffic from EB Route 20 to SB Grafton in the P.M. peak hour operate at LOS "E".

The following movements operate or unacceptable LOS "F":

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.
- All NB traffic from the Truck Business in the P.M. peak hour.

No peak hour level of service rating drops will result at the unsignalized intersections from the traffic entering or exiting the commuter rail station.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.3-8 lists the results of the analysis of the A.M. and P.M. peak hours.

As shown in the table, most of the analyzed roadway segments are operating in the "No Build" condition at the peak hour level of service rating of "E". However, all but four of the segments analyzed operate within the acceptable range of reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

- Route 122 North of Exit 11 in the P.M. peak hour.
- Route 122 North of Wheelock in the P.M. peak hour.
- Route 20 West of Grafton St. in the A.M. and P.M. peak hours.

As shown in the table, most of the analyzed roadway segments are operating in the "Build" condition at peak hour level of service rating of "E". However, all but four of the segments analyzed operate within the acceptable range of reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

- Route 122 North of Exit 11 in the P.M. peak hour.
- Route 122 North of Wheelock in the P.M. peak hour.
- Route 20 West of Grafton St. in the A.M. and P.M. Peak Hours.

No peak hour level of service rating drops will result in the roadway segments from the traffic entering or exiting the commuter rail station.

Table 1.3-8 1996 Peak Hour Road Segment Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(949)	E(810)	E(935)	E(810)
Route 122 North of Exit 11	E(706)	E(396)	E(707)	E(391)
Route 122 North of Wheelock	E(610)	E(213)	E(591)	E(208)
Route 20 West of Route 122	E(307)	E(449)	E(289)	E(444)
EB Route 20 West of Mall	B(1995)	A(2353)	B(1995)	A(2353)
WB Route 20 West of Mall	A(2383)	B(2139)	A(2383)	B(2139)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Peak Generator Hour Level Of Service

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-9 lists the results of the signalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 1996 "No Build" and "Build" conditions.

Table 1.3-9 1996 Peak Generator Hour Signalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	A(4.2)	B(7.5)	B(8.9)	B(14.6)
Eastbound	A(2.2)	B(6.9)	B(9.9)	B(14.1)
Westbound	A(3.4)	B(7.1)	B(6.5)	B(8.4)
Northbound	B(9.9)	B(8.4)	C(16.3)	C(20.5)
Southbound	-	-	B(14.3)	D(28.3)
Route 122 and Wheelock**	A(2.8)	A(2.2)	A(3.4)	A(2.2)
Eastbound	A(2.0)	A(1.3)	A(1.4)	A(1.3)
Westbound	A(2.0)	A(1.7)	A(1.5)	A(1.7)
Northbound	B(9.0)	C(15.1)	C(20.5)	C(15.1)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Under the 1996 "No Build" conditions both intersections will operate at overall acceptable level of service ratings. None of the movements will see excessive delay.

Under the 1996 "Build" conditions the intersections will also operate at overall acceptable level of service ratings in the peak generator hour. None of the movements will see excessive delay.

The level of service rating for the northbound movement at Exit 11 will change from "B" to "C" during the A.M. peak hour. The level of service rating at Wheelock Avenue will change from "B" to "C" during the A.M. peak hour. However, all movements will operate at acceptable level of service ratings.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-10 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 1996 "No Build" and "Build" conditions.

Table 1.3-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(395)	A(427)	B(391)	A(410)
LT and RT from Ramp	D(149)	D(124)	D(147)	D(115)
SB Grafton and Route 20 East				
RT from Ramp	C(291)	B(384)	C(274)	B(379)
NB Grafton and Route 20 East				
RT from Ramp	B(370)	B(342)	B(367)	B(334)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(565)	B(370)	A(561)	B(354)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(480)	A(654)	A(474)	A(652)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	A(422)	A(581)	A(422)	A(581)
Route 20 and Mall				
LT from EB Route 20	A(480)	B(301)	A(485)	B(301)
LT from WB Route 20	C(297)	A(533)	C(297)	A(533)
All from Truck Business	D(105)	D(103)	D(107)	D(103)
RT from Mall	A(678)	A(452)	A(681)	A(452)

LOS (Reserve Capacity - Vehicles)

As shown in the table, all of the analyzed intersection movements in the "No Build" condition are operating at acceptable level of service ratings.

As shown in the table, all of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings.

No reduction in peak hour level of service will result at the unsignalized intersections from the traffic entering or existing the commuter rail station.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.3-11 lists the results of the analysis of the A.M. and P.M. peak generator hours.

As shown in the table, half of the analyzed roadway segments are operating in the "No Build" condition at the peak hour level of service rating of "E". However, all but one segment operate within the acceptable range of reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton St. in the A.M. Peak Generator Hour.

As shown in the table, half of the analyzed roadway segments are operating in the "Build" condition at the peak generator hour level of service rating of "E". However, all but one segment operate within the acceptable range of reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton St. in the A.M. Peak Generator Hour.

No peak generator hour level of service rating drops will result in the roadway segments from the traffic entering or exiting the commuter rail station.

Table 1.3-11 1996 Peak Generator Hour Road Segment Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	D(1040)	D(1350)	D(1040)	D(1350)
Route 122 North of Exit 11	E(811)	E(892)	E(788)	E(869)
Route 122 North of Wheelock	E(868)	E(854)	E(846)	E(832)
Route 20 West of Route 122	E(553)	E(853)	E(532)	E(817)
EB Route 20 West of Mall	A(2165)	A(2449)	A(2165)	A(2449)
WB Route 20 West of Mall	A(2552)	A(2365)	A(2552)	A(2365)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis

The Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.3-12 lists the site generated traffic as a percentage of the total traffic at the various intersections and road segments analyzed within the study area during the 1996 A.M. and P.M. peak hours.

As shown in the table, none of the intersections or road segments analyzed exceed the 10 percent requirement.

Table 1.3-12 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Route 122 and Exit 11	2.8%	0.6%
Route 122 and Wheelock	3.2%	0.7%
Route 122 NB and EB 20 Ramp	2.7%	0.6%
Route 122 SB and EB 20 Ramp	2.8%	0.6%
Route 122 and WB Route 20 Ramp	1.0%	0.5%
Route 20 EB and SB 122 Ramp	2.7%	0.1%
Route 20 EB and NB 122 Ramp	0.0%	0.1%
Route 20 WB and Route 122 Ramp	1.1%	0.7%
Route 20 and Mall and Driveway	0.3%	0.0%
Roadway Segment		
Route 122 South of Exit 11	0.0%	0.0%
Route 122 North of Exit 11	3.5%	0.8%
Route 122 North of Wheelock	2.8%	0.6%
Route 20 West of Route 122	2.1%	0.5%
Route 20 West of Mall	0.3%	0.0%

Site generated traffic as a percentage of total traffic

Year 1996 Millbury Station Only

In order to address an upper limit, worst case situation with regard to traffic impacts on Millbury Streets, an analysis was performed which considered that the Millbury commuter station was the only commuter station built by 1996 (in addition to a Worcester Station).

The 1996 "No Build" traffic volumes, for both the peak hours and peak generator hours, were previously presented and service as the same base for the "Millbury Station Only" as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Millbury Station Only)

In support of this study the Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership for the Millbury Station, employing an unconstrained parking supply. In 1996, the Millbury Station is projected to attract

347 daily round trip commuters, 319 of which would be Park'n'Ride patrons. These patrons are expected to reside in the Towns of Millbury, Shrewsbury, Grafton, Sutton, Boylston, Northbridge, Oxford, Charlton, Auburn and the City of Worcester. The number of patrons who originate from each community are shown in Table 1.3-13. The Ridership has been adjusted to reflect peak period usage which is 94% of the total daily demand.

Table 1.3-13 Projected Patrons of Millbury Station Only Year 1996

City/Town	Riders*
Millbury	28
Grafton	35
Shrewsbury	77
Sutton	15
Boylston	16
Northbridge	26
Oxford	18
Charlton	20
Auburn	27
Worcester	64
TOTAL	**326**

* *Adjusted for Peak Period Demand*

Year 1996 Trip Distribution and Assignment (Millbury Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.3-14 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.3-14 MBTA Ridership Distribution (Millbury Station Only)

Inbound Train	Patrons
502A	64
504A	105
506A	106
510	51
TOTAL	**326**
Outbound Train	**Patrons**
515A	46
519	76
521	75
521A	113
523	16
TOTAL	**326**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Millbury Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Millbury the typical A.M. and P.M. roadway peak hours are from 7:15 to 8:15 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 6:00 to 7:00 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Millbury would utilize eastbound Route 20 or northbound Wheelock Avenue, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station. Actual routing was based on shortest travel time and distance from population centers. Figure 1.3-15 shows the percentage of station related traffic utilizing the study area roadways.

Year 1996 "Build" Traffic Volumes (Millbury Station Only)

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Millbury station.

A portion of the traffic volumes heading to the proposed station would be diverted from the existing travel route to the Mass Pike, (travel route being Grafton Street, Route 122). These existing vehicle trips would not be generated as new trips. The vehicles currently by-passing the site were not assigned to the roadway network as new trips, they are only shown as being diverted from the Mass Pike to the commuter rail site.

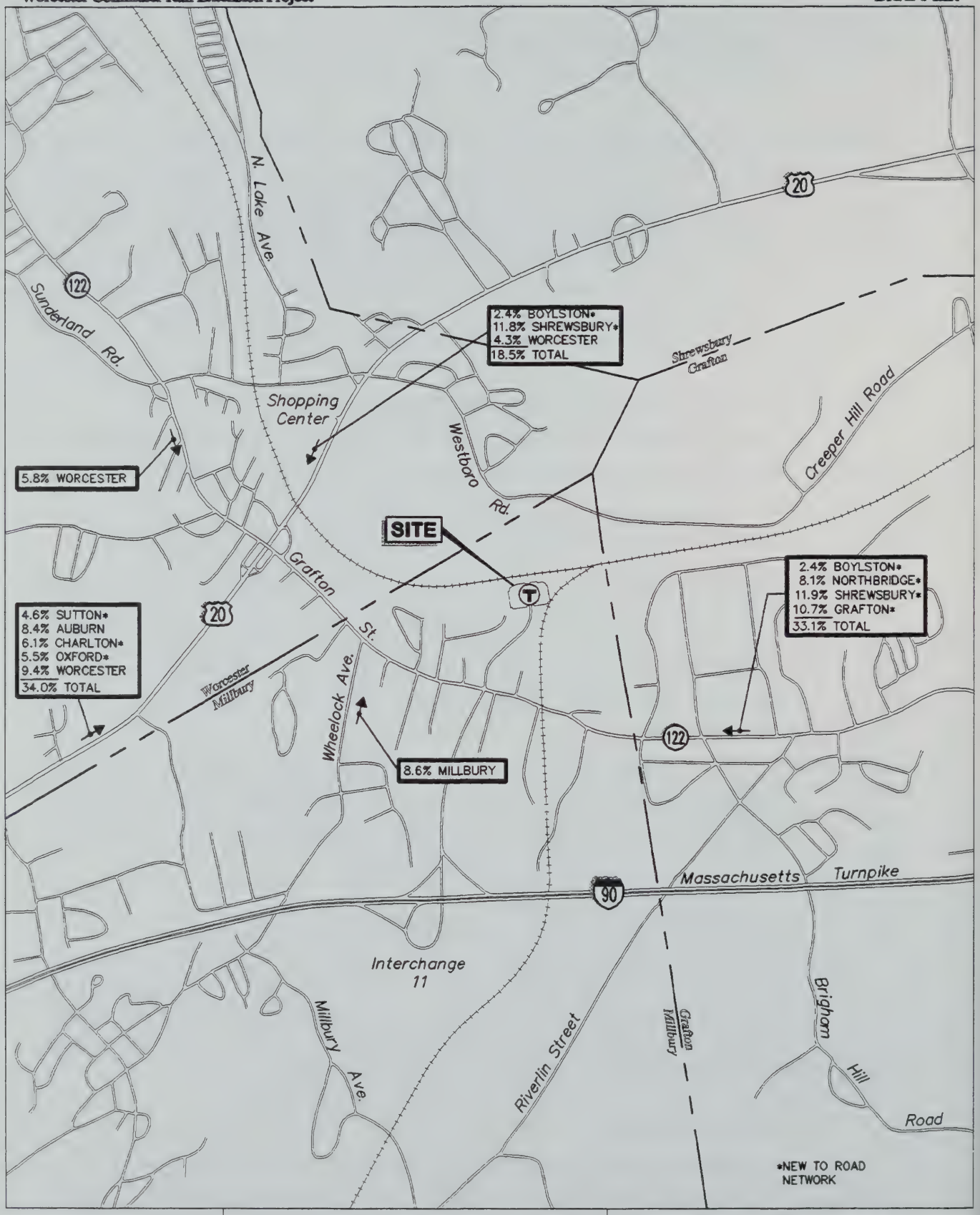
Figure 1.3-16 shows the projected A.M. peak hours traffic volumes. Figure 1.3-17 shows the projected P.M. peak hour traffic volumes. Figure 1.3-18 shows the projected A.M. peak generator hour traffic volumes. Figure 1.3-19 shows the projected P.M. peak generator hour traffic volumes.

Year 1996 Peak Hour Level of Service (Millbury Station Only)

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics, etc. remain unchanged.

Signalized Intersection

The signalized intersections were analyzed using the same methodology as in the Existing conditions. Table 1.3-15 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

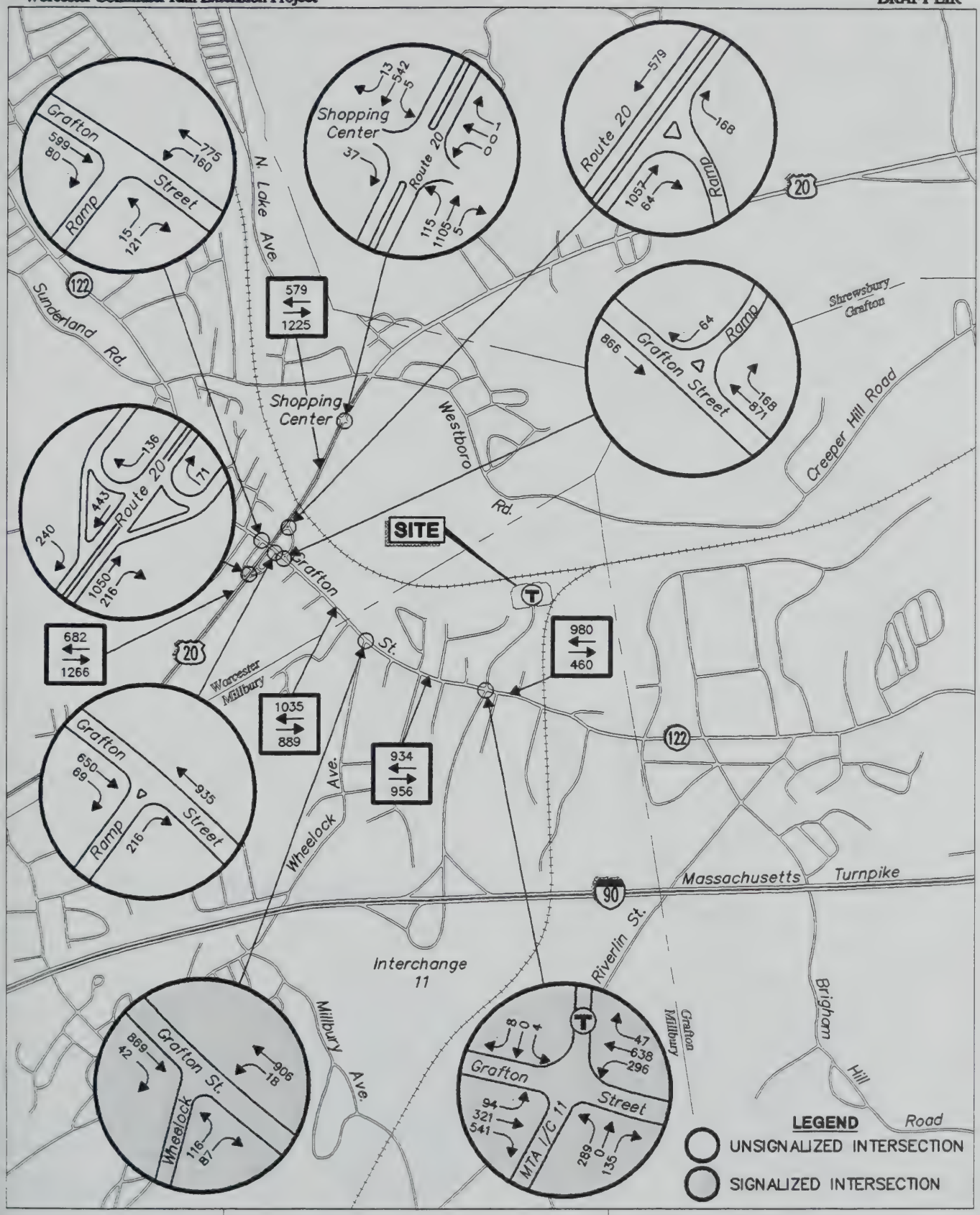


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

Distribution of Commuter Rail Station Traffic 1996 BUILD Millbury Only Millbury Station - Route 122

FIGURE 1.3-15



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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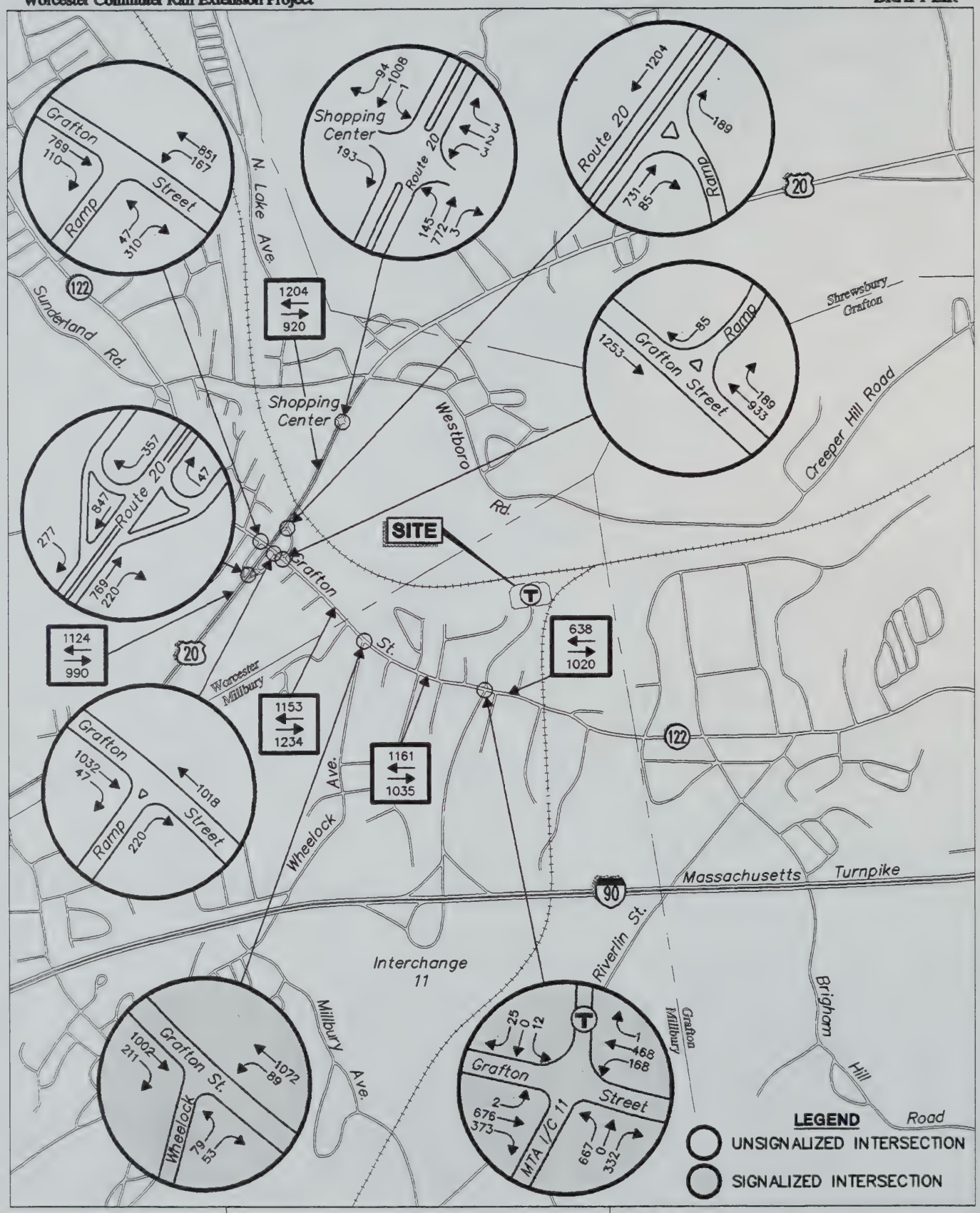
A.M Peak Hour
7:15 - 8:15 A.M.
1996 BUILD Millbury Only
Millbury Station - Route 122

FIGURE 1.3-16



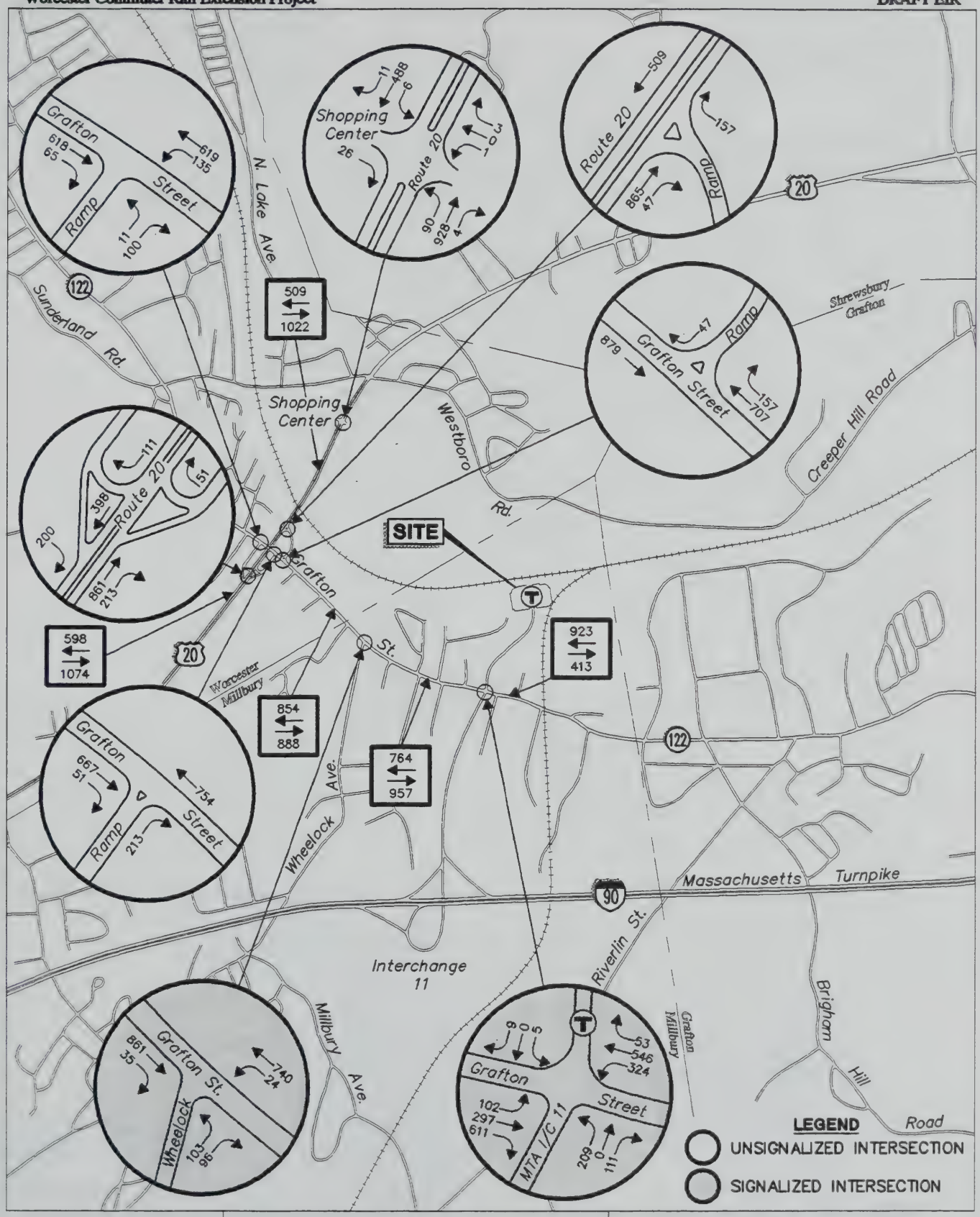
Massachusetts Bay Transportation Authority

Approx. Scale: 1"= 1750'±

0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD Millbury Only
Millbury Station - Route 122

FIGURE 1.3-17



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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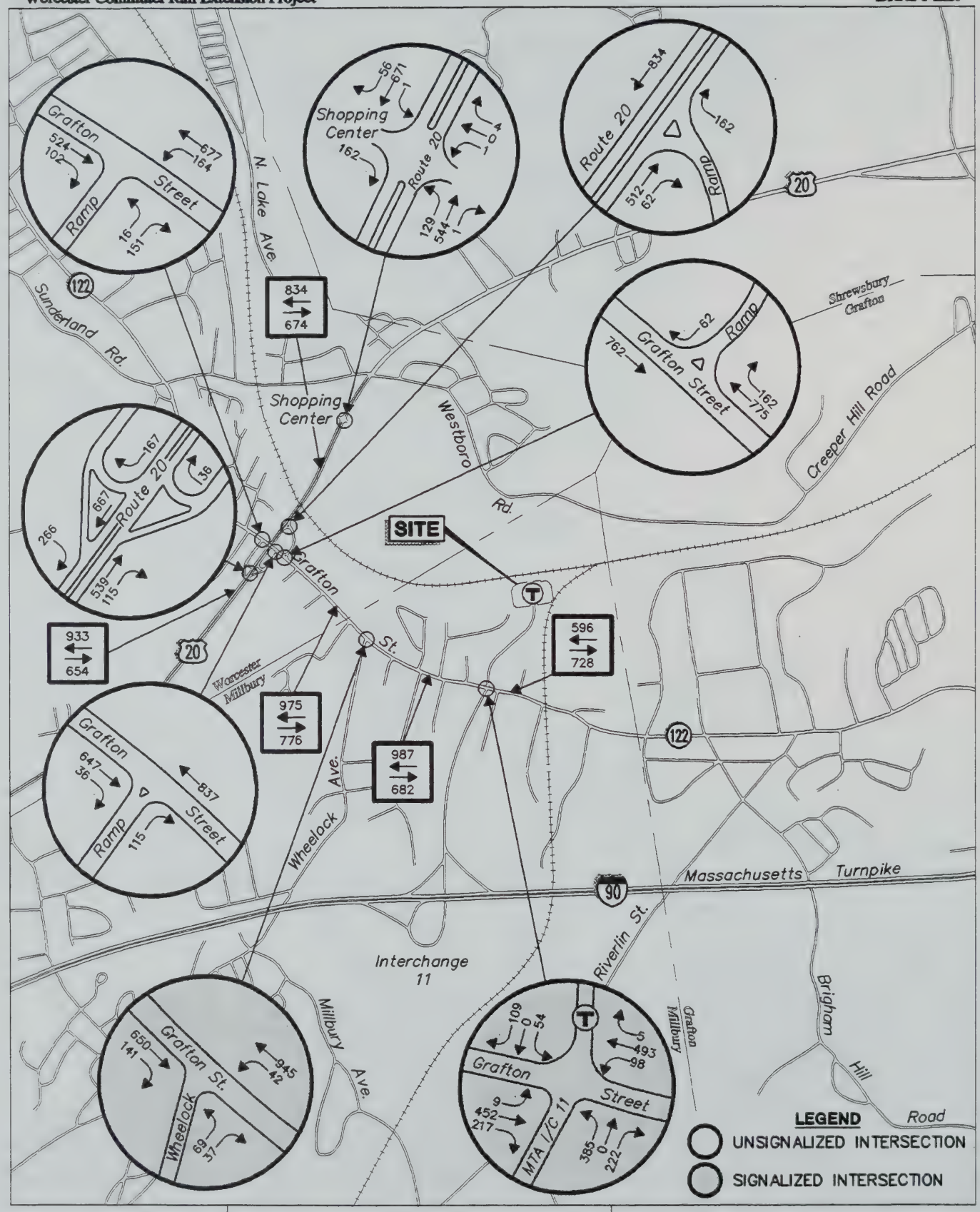
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 BUILD Millbury Only
Millbury Station - Route 122

FIGURE 1.3-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1996 BUILD Millbury Only
Millbury Station - Route 122

FIGURE 1.3-19

Under the 1996 "No Build" condition both existing intersections will operate at overall acceptable level of service ratings. The northbound movement at Exit 11 will operate at level of service rating "E" in the P.M. peak hour.

Under the 1996 "Build" condition both intersections are expected to operate at acceptable level of service ratings. The Grafton Street/Exit 11 intersection is expected to operate at level of service rating "E" in the P.M. peak hour. The eastbound movement at this intersection will function at level of service rating "E" while the northbound and southbound movements will function at level of service rating "F" in the P.M. peak hour. The northbound movement at Wheelock Avenue is expected to function at level of service rating "E" in the P.M. peak hour.

Table 1.3-15 1996 Peak Hour Signalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(5.4)	D(34.6)	B(11.1)	E(56.6)
Eastbound	A(2.6)	C(15.1)	B(6.0)	E(55.0)
Westbound	A(4.4)	D(26.7)	B(9.9)	D(33.8)
Northbound	B(11.2)	E(59.6)	C(21.5)	F(65.4)
Southbound	-	-	C(19.4)	F(320.8)
Route 122 and Wheelock**	A(2.6)	B(6.0)	B(8.0)	D(27.4)
Eastbound	A(2.0)	A(1.4)	B(6.8)	D(39.2)
Westbound	A(2.1)	B(6.3)	B(6.1)	B(11.4)
Northbound	B(10.2)	D(34.5)	C(21.4)	E(52.3)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-16 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

As shown in the table, the analyzed intersection movements in the "No Build" condition generally operate at acceptable level of service ratings. Traffic turning from

WB Route 20 to Grafton Street is at LOS "E" in the A.M. peak hour, while traffic turning from EB Route 20 to SB Grafton Street is at LOS "E" in P.M. peak hour.

The following movements operate at unacceptable LOS "F":

- Left and right traffic from WB Route 20 to Grafton Street in the P.M. peak hour.
- All NB traffic movements from the truck business at Route 20 in the P.M. peak hour.

As shown in the table most of the analyzed intersection movements in the "Build" condition continue to operate at acceptable level of service ratings. As in the "No Build" condition, traffic from WB Route 20 to Grafton Street and traffic from EB Route 20 To SB Grafton Street will operate at LOS "E".

The following movements operate at unacceptable LOS "F":

- Left and right turning traffic from WB Route 20 to Grafton Street in the P.M. peak hour.
- All NB traffic movements from the truck business at Route 20 in the P.M. peak hour.

Reduction in level of service as the result of traffic entering or existing the proposed station will occur at the following locations:

- Right turning traffic from the Grafton Street ramp to WB Route 20 in the P.M., "C" to "D".
- Left turning traffic from EB Route 20 to the existing shopping center in the A.M., "A" to "B".

Table 1.3-16 1996 Peak Hour Unsignalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(371)	C(250)	B(367)	C(244)
LT and RT from Ramp	E(66)	F(-253)	E(57)	F(-257)
SB Grafton and Route 20 East				
RT from Ramp	C(287)	E(68)	C(249)	E(66)
NB Grafton and Route 20 East				
RT from Ramp	C(270)	C(218)	C(267)	C(214)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(488)	C(204)	A(475)	D(198)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	B(393)	A(507)	B(386)	A(506)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(334)	A(433)	B(322)	A(428)
Route 20 and Mall				
LT from EB Route 20	A(413)	D(121)	B(399)	D(120)
LT from WB Route 20	C(22)	B(380)	C(226)	B(377)
All from Truck Business	A(448)	F(-4)	A(448)	F(-4)
RT from Mall	A(641)	C(289)	A(631)	C(288)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.3-17 lists the results of the analysis for the A.M. and P.M. peak hours.

As shown in the table most of the analyzed road segments are operating in the "No Build" condition at the peak hour level of service rating of "E". Of the road segments operating at level of service rating "E" the following have an unacceptable reserve capacity:

- Route 122 North of Exit 11 in the P.M. peak hour.
- Route 122 North of Wheelock in the P.M. peak hour.
- Route 20 West of Grafton Street in the A.M. and P.M. peak hours.

As shown in the table most of the analyzed road segments are operating in the "Build" condition at the peak hour level of service rating of "E". Of the road segments operating at level of service rating "E" the following have an unacceptable reserve capacity:

- Route 122 North of Exit 11 in the P.M. peak hour.
- Route 122 North of Wheelock in the P.M. peak hour.
- Route 20 West of Grafton Street in the A.M. and P.M. peak hours.

Table 1.3-17 1996 Peak Hour Road Segment Level of Service (Millbury Station Only)

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(949)	E(810)	E(868)	E(783)
Route 122 North of Exit 11	E(706)	E(396)	E(637)	E(382)
Route 122 North of Wheelock	E(610)	E(213)	E(574)	E(179)
Route 20 West of Route 122	E(307)	E(449)	E(279)	E(442)
EB Route 20 West of Mall	B(1995)	A(2353)	B(1999)	A(2366)
WB Route 20 West of Mall	A(2383)	B(2139)	A(2468)	B(2140)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Peak Generator Hour Level of Service (Millbury Station Only)

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.3-18 for the 1996 "No Build" and "Build" conditions.

As shown in the table both intersections will operate at acceptable level of service ratings under the "No Build" conditions. None of the movements analyzed will experience excessive delay.

As shown in the table both intersections continue to operate at acceptable level of service ratings under the "Build" condition. Minor changes in overall level of service ratings are expected to occur at both intersections. Only the southbound movement

from the proposed site driveway is anticipated to experience some excessive delay during the P.M. peak generator hour.

Table 1.3-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	A(4.2)	B(7.5)	B(9.6)	C(23.9)
Eastbound	A(2.2)	B(6.9)	B(13.0)	D(25.8)
Westbound	A(3.4)	B(7.1)	B(6.8)	B(10.8)
Northbound	B(9.9)	B(8.4)	C(16.3)	D(28.1)
Southbound	-	-	C(17.1)	E(51.3)
Route 122 and Wheelock**	A(2.8)	A(2.2)	B(7.7)	B(11.7)
Eastbound	A(2.0)	A(1.3)	B(7.5)	A(4.3)
Westbound	A(2.0)	A(1.7)	A(4.6)	C(16.8)
Northbound	B(9.0)	C(15.1)	C(20.5)	C(15.1)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed for the A.M. and P.M. peak generator hours for both the "No Build" and "Build" conditions. The results of the analysis are listed in Table 1.3-19.

Under the "No Build" condition all intersection movements will operate at acceptable level of service ratings. No movements are expected to experience excessive delay.

Under the "Build" condition all movements will operate at acceptable level of service ratings. Northbound traffic from the existing truck business at Route 20 will operate at level of service rating "E" during the A.M. and P.M. peak generator hours.

The following movements will experience a change in level of service between the "No Build" and "Build" condition:

- Left turns from EB Route 20 to the existing shopping center in the P.M. peak generator hour, "B" to "C".
- NB traffic from the truck business to Route 20 in the A.M. and P.M. peak generator hours, "D" to "E".

Table 1.3-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(395)	A(427)	B(390)	A(401)
LT and RT from Ramp	D(149)	D(124)	D(144)	D(109)
SB Grafton and Route 20 East				
RT from Ramp	C(291)	B(384)	C(249)	B(376)
NB Grafton and Route 20 East				
RT from Ramp	B(370)	B(342)	B(366)	B(322)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(565)	B(370)	A(549)	B(342)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(480)	A(654)	A(471)	A(652)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	A(422)	A(581)	A(419)	A(557)
Route 20 and Mall				
LT from EB Route 20	A(480)	B(301)	A(463)	C(300)
LT from WB Route 20	C(297)	A(533)	C(295)	A(517)
All from Truck Business	D(105)	D(103)	E(99)	E(97)
RT from Mall	A(678)	A(452)	A(667)	A(451)

Roadway Segments

The roadway segments were analyzed for the A.M. and P.M. peak generator hours for the "No Build" and "Build" conditions. The results of the analysis are listed in Table 1.3-20.

Under the "No Build" condition several segments operate at a level of service rating of "E". However, only Route 20 west of Route 122 during the A.M. peak generator hour has an unacceptable reserve capacity.

Under the "Build" condition most segments continue to operate at a level of service rating of "E". Route 20 west of Route 122 during the A.M. peak generator hour continues to have an unacceptable reserve capacity. Route 122 south of Exit 11

experiences a decline in level of service rating from "D" to "E" during the A.M. peak generator hour.

Table 1.3-20 1996 Peak Generator Hour Segment Level of Service (Millbury Station Only)

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	D(1040)	D(1350)	E(1012)	D(1254)
Route 122 North of Exit 11	E(811)	E(892)	E(734)	E(815)
Route 122 North of Wheelock	E(868)	E(854)	E(792)	E(778)
Route 20 West of Route 122	E(553)	E(853)	E(520)	E(805)
EB Route 20 West of Mall	A(2165)	A(2449)	A(2172)	A(2390)
WB Route 20 West of Mall	A(2552)	A(2365)	A(2485)	A(2373)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis (Millbury Station Only)

The Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.3-21 lists the site generated traffic as a percentage of the total traffic at the various intersections and road segments analyzed within the study area during the 1996 A.M. and P.M. peak hours.

As shown in the table, none of the intersections or road segments analyzed exceed the 10 percent requirement.

Table 1.3-21 1996 "Build" Condition - 10% Analysis (Millbury Station Only)

Intersection	Peak Hours	
	A.M.	P.M.
Route 122 and Exit 11	6.2%	1.5%
Route 122 and Wheelock	6.0%	1.1%
Route 122 NB and EB 20 Ramp	5.4%	1.0%
Route 122 SB and EB 20 Ramp	5.5%	0.7%
Route 122 and WB Route 20 Ramp	2.5%	0.7%
Route 20 EB and SB 122 Ramp	4.8%	0.1%
Route 20 EB and NB 122 Ramp	2.8%	0.7%
Route 20 WB and Route 122 Ramp	4.8%	0.9%
Route 20 and Mall and Driveway	2.0%	0.4%
Roadway Segment		
Route 122 South of Exit 11	4.3%	0.8%
Route 122 North of Exit 11	6.5%	1.2%
Route 122 North of Wheelock	5.5%	1.0%
Route 20 West of Route 122	3.5%	0.7%
Route 20 West of Mall	2.1%	0.4%

Site generated traffic as a percentage of total traffic

Year 2001 Conditions

To determine the impacts directly attributable to the proposed rail station, the year 2001 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

Year 2001 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments within the study area.

- Increases in existing traffic volumes due to population growth and development within the vicinity of, but outside of the study area.

Through discussions with the Town of Millbury, it was determined that no major new developments are planned within the study area by 2001. Therefore, this element does not affect the estimation of the 2001 "No Build" traffic volumes.

Current economic projections are for positive growth of 1.4% in 1996 and for 1.6% in 1997. If these projections are correct the growth in the background traffic volumes should also start increasing to a more normal rate of around 1.5% per year.

To account for the expected return to normal economic times the 1996 "No Build" traffic volumes were increased by 1.5% per year to obtain the year 2001 "No Build" traffic volumes.

Figure 1.3-20 shows the projected A.M. peak hour traffic volumes. Figure 1.3-21 shows the projected P.M. peak hour traffic volumes. Figure 1.3-22 shows the projected A.M. peak generator hour traffic volumes. Figure 1.3-23 shows the projected P.M. peak generator hour traffic volumes.

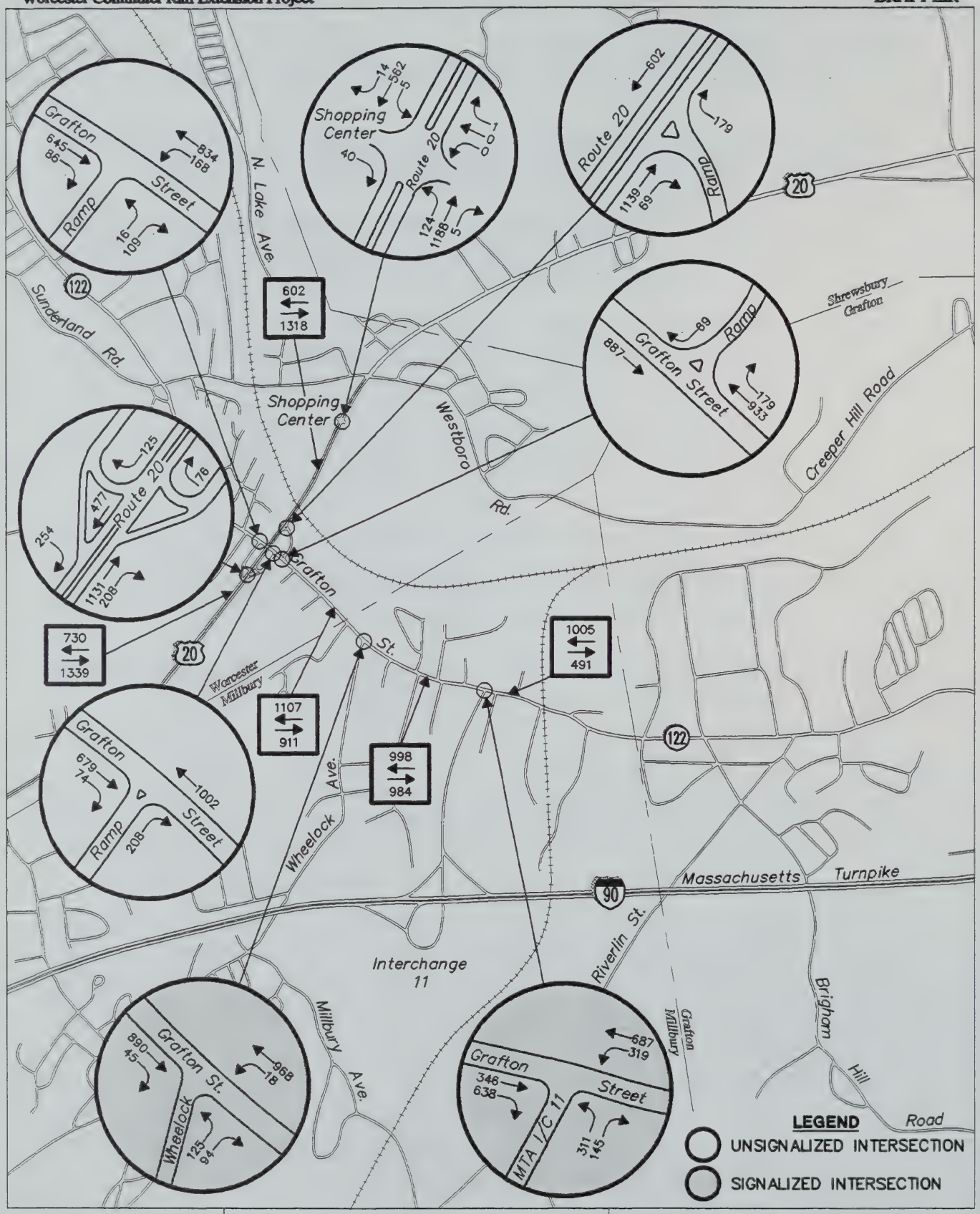
The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to Worcester.

Year 2001 Trip Generation and Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 commuters are expected to utilize the railroad for daily round trip commuting into Boston.

In 2001, the proposed Millbury Station is projected to attract a total of 162 daily round trip commuters. Thirteen of these patrons would be dropped off at the station. Based upon an average automobile occupancy rate of 1.12, the remaining 149 patrons would result in a parking demand of 133 parking spaces. This leaves 167 parking spaces empty in the year 2001.

These patrons are expected to reside in the Towns of Auburn, Charlton, Millbury, Oxford, and the City of Worcester. The number of patrons who originate from each town are shown in Table 1.3-22. The ridership has been adjusted to reflect peak period usage, which is 94% of the total daily demand.



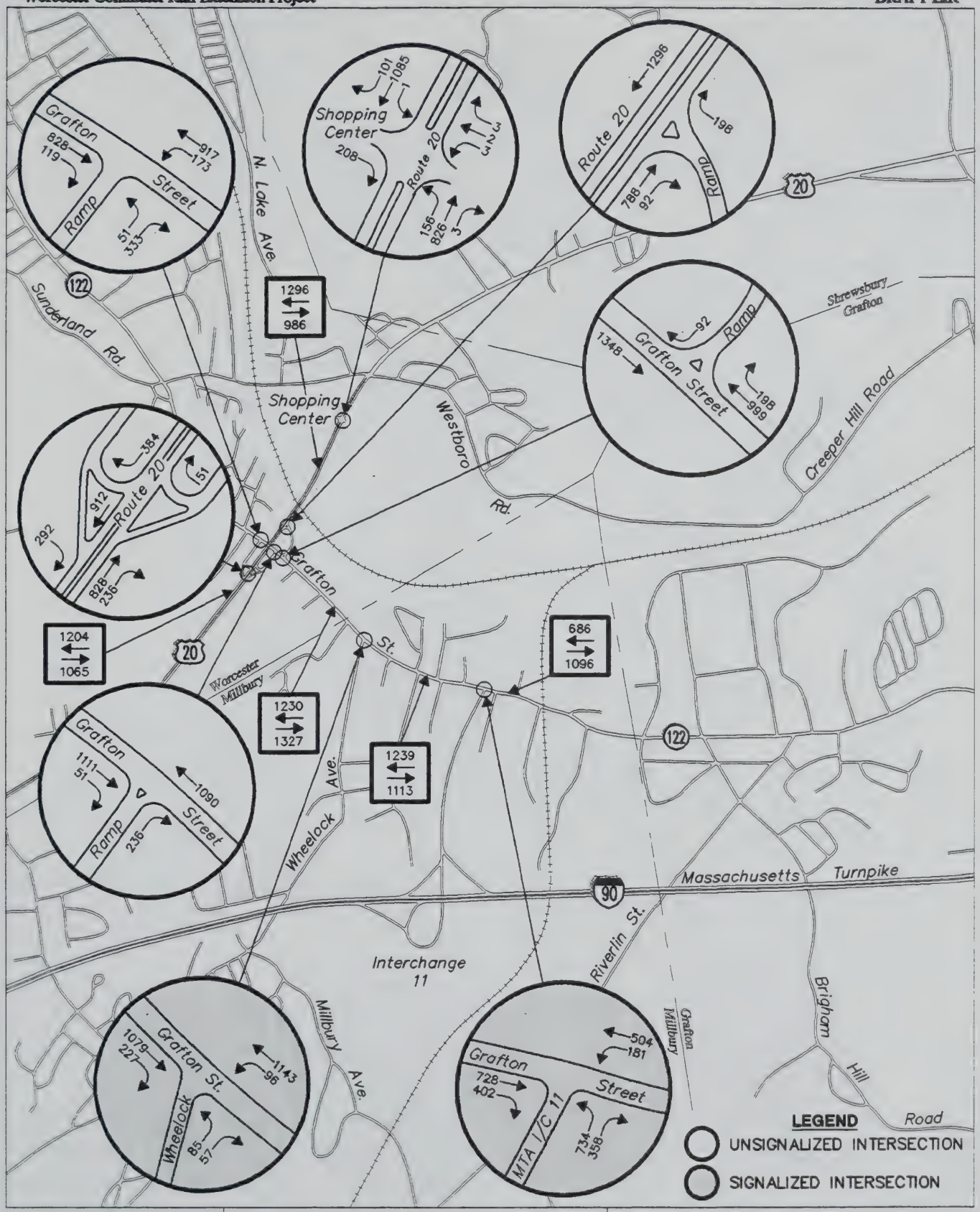
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:15 - 8:15 A.M.
2001 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-20



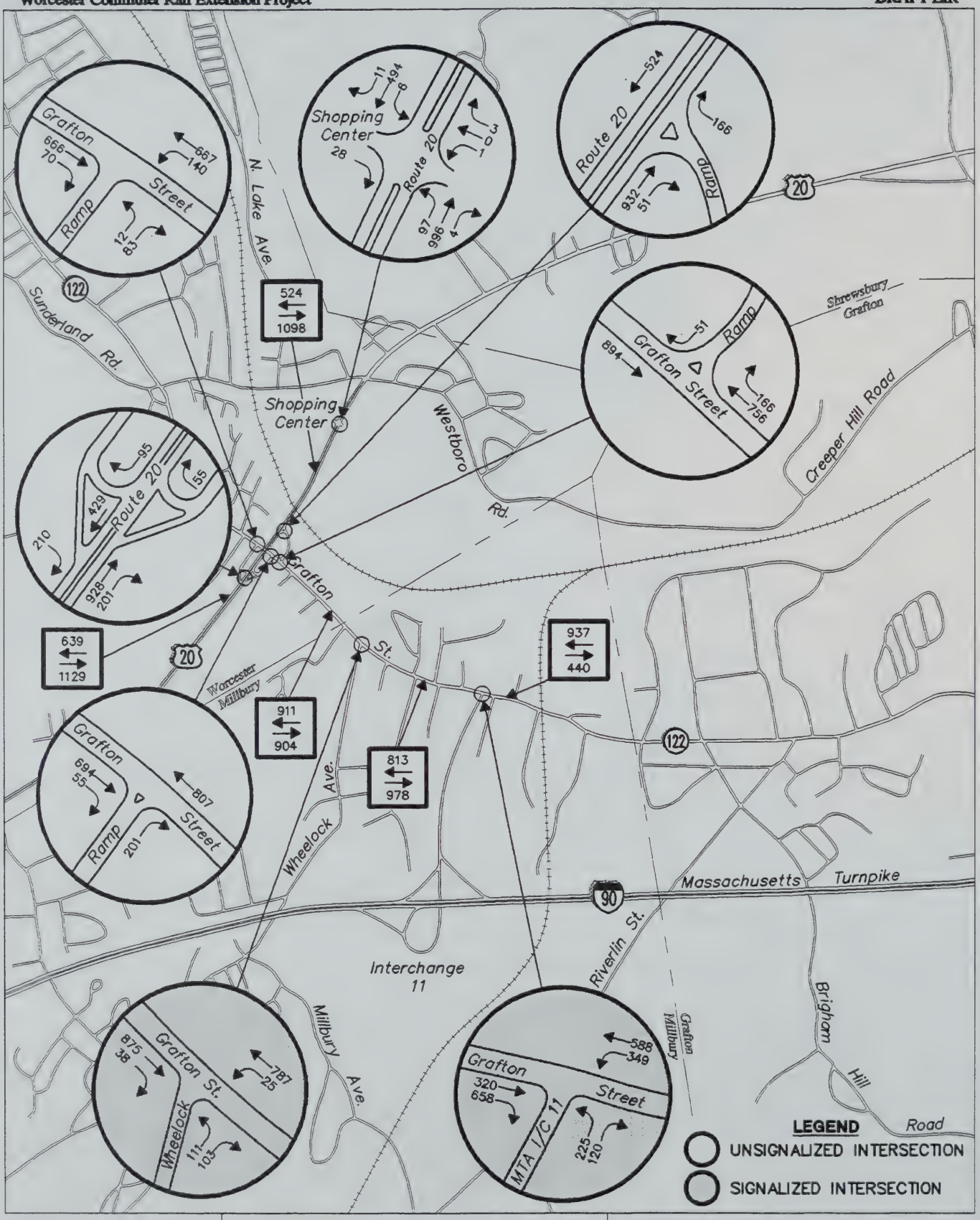
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
2001 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-21

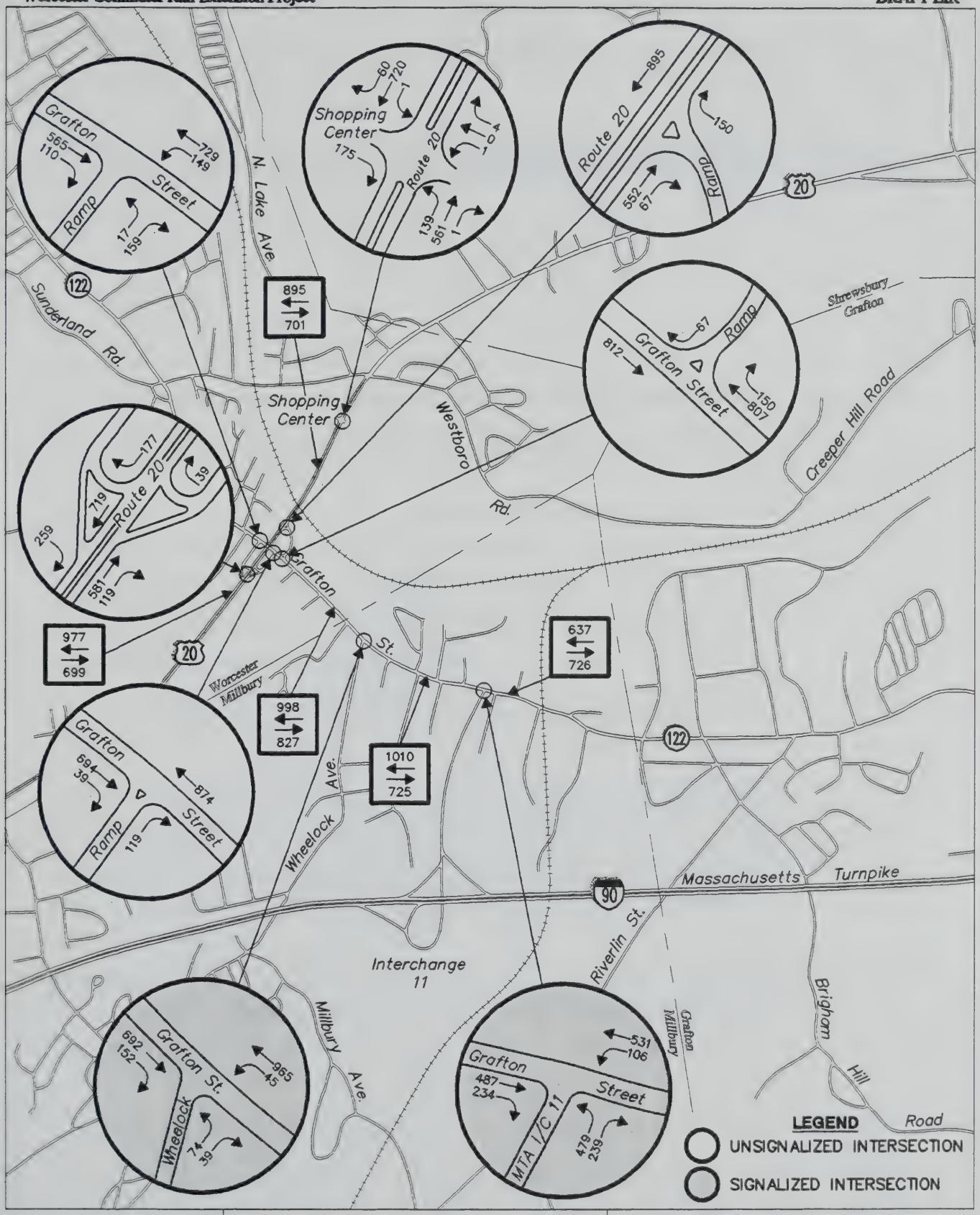


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
2001 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-22



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
2001 NO BUILD
Millbury Station - Route 122

FIGURE 1.3-23

Table 1.3-22 Projected Patrons of Millbury Station - Year 2001

Town	Riders*
Auburn	31
Charlton	17
Millbury	25
Oxford	18
Worcester	61
TOTAL	**152**

* *Adjusted for peak period demand*

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day (7:30, 8:00, 8:30, or 9:00) will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business (4:30, 5:00, 5:30, or 6:00 P.M.) are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on current ridership per train and the arrival or departure times in Boston of said trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.3-23 lists the projected distribution of ridership from the Millbury Station based on the expected arrival in Boston or departure time from Boston.

Table 1.3-23 MBTA Ridership Distribution

Inbound Train	Patrons
502A	30
504A	49
506A	49
510	24
TOTAL	**152**
Outbound Train	**Patrons**
515A	21
519	35
521	35
521A	53
523	8
TOTAL	**152**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the out of pocket cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time typically results in the A.M. and P.M. peak hours for the site to lie totally or partially outside of the typical peak hour ranges of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M. thus there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Millbury Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Millbury the typical A.M. and P.M. intersection peak hours are from 7:15 to 8:15 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 6:00 to 7:00 P.M.

Once the project generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Millbury would utilize eastbound Route 20 or northbound Wheelock Avenue, depending on the location of their residences. Riders originating in towns outside that which the station is located were assigned to the major roads from their town to the station.

The patrons from Auburn, Charlton, and Oxford would access the station from eastbound U.S. Route 20. The patrons from Worcester would access the station from eastbound Route 20, westbound Route 20, or southbound Route 122. Actual routing was estimated based on the shortest travel time and distance from population centers. Figure 1.3-24 shows the percentage of station related traffic utilizing the study area roadways for the year 2001 "Build" condition.

Approximately the same number of vehicle trips will be made in the Study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along the Mass Pike. Traffic volumes are expected to increase on Route 20 west of Route 122.

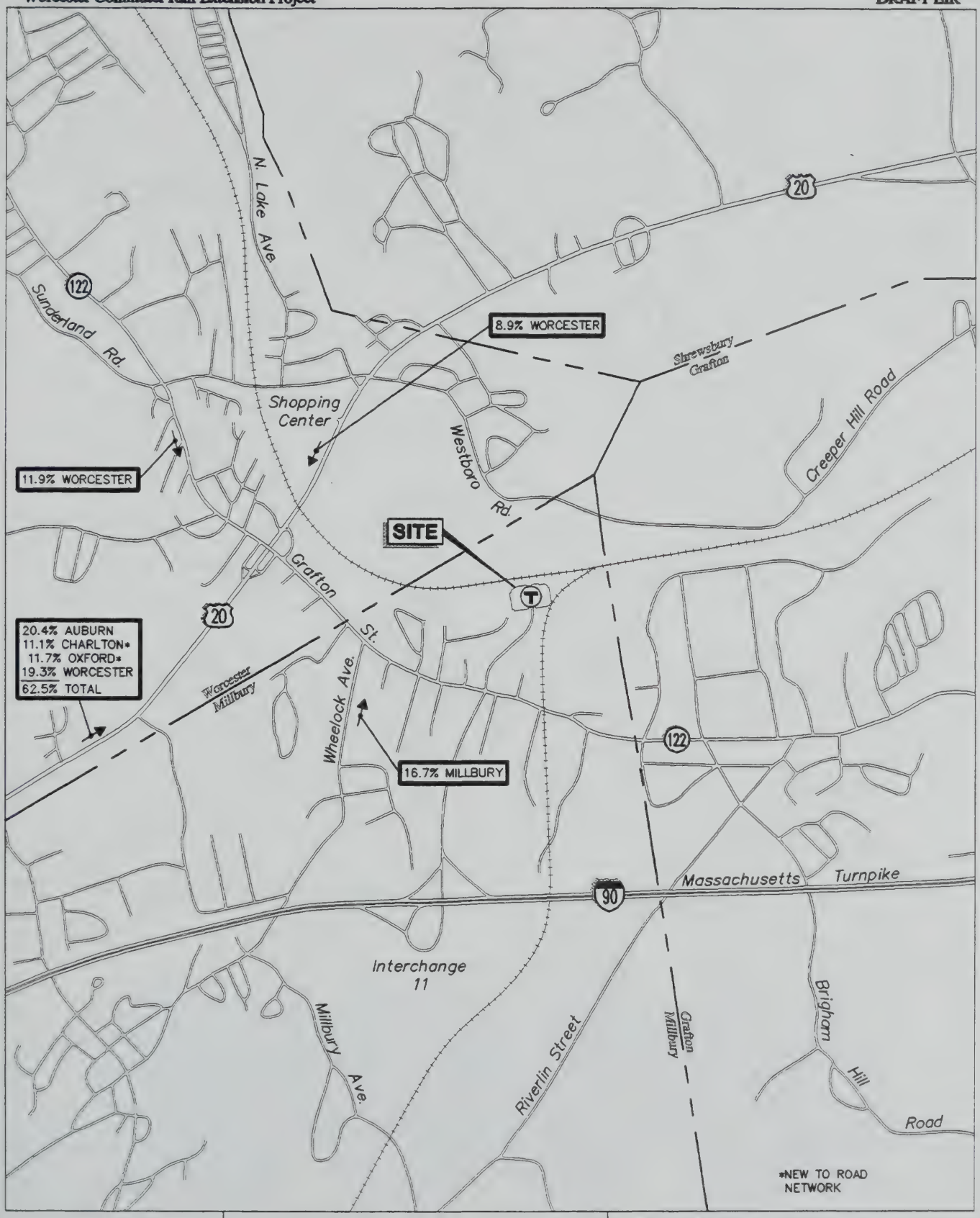
Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

- The projected year 2001 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Millbury rail station.

A portion of the traffic volumes heading to the proposed station would be diverted from the existing travel route to the Mass Pike (the travel route being Grafton Street, Route 122). These existing vehicle trips would not be generated as new trips. The vehicles currently by-passing the site were not assigned to the roadway network as new trips, they are only shown as being diverted from the Mass Pike to the commuter rail site.

Figure 1.3-25 shows the projected A.M. peak hour traffic volumes. Figure 1.3-26 shows the projected P.M. peak hour traffic volumes. Figure 1.3-27 shows the projected A.M. peak generator hour traffic volumes. Figure 1.3-28 shows the projected P.M. peak generator hour traffic volumes.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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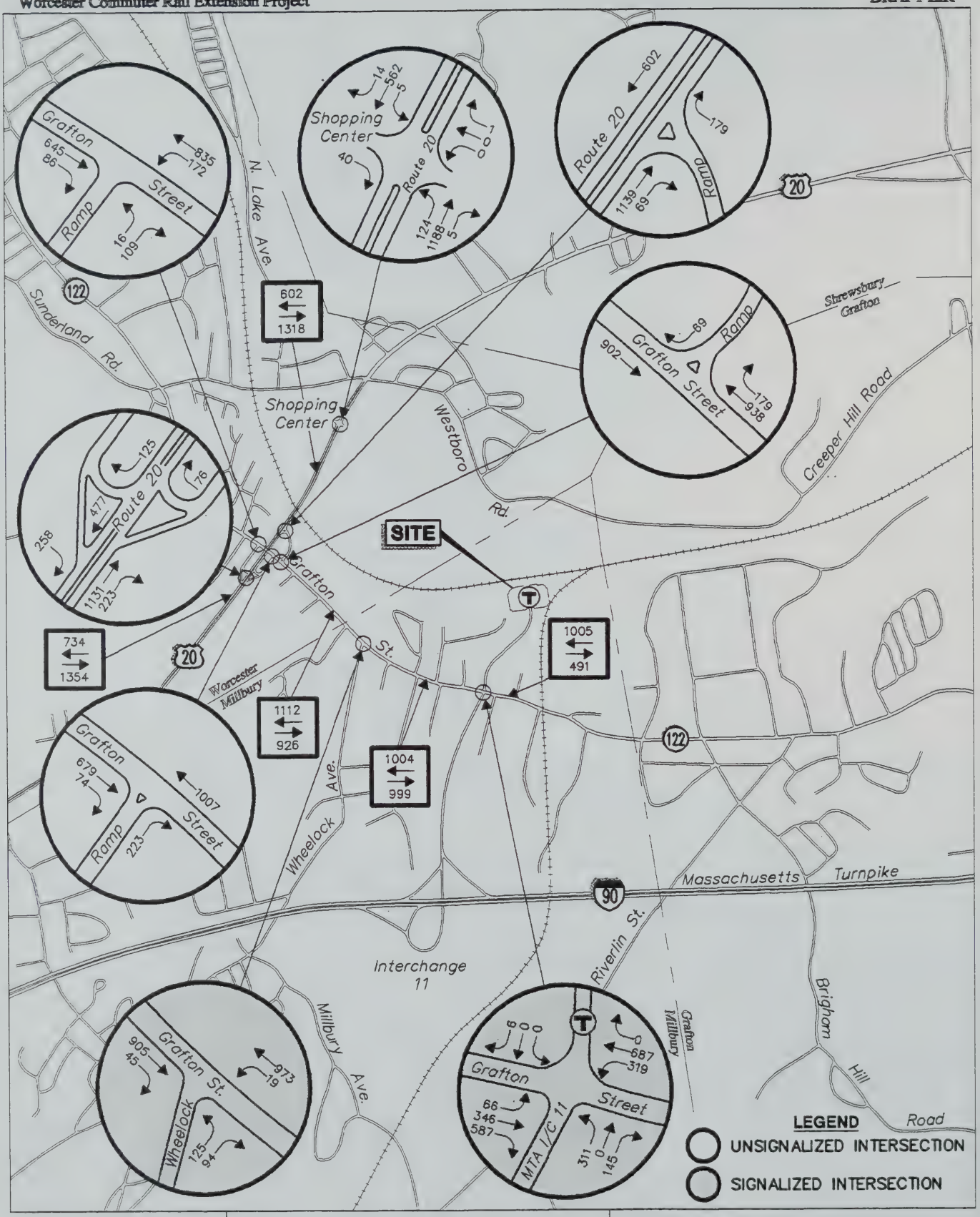
Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-24



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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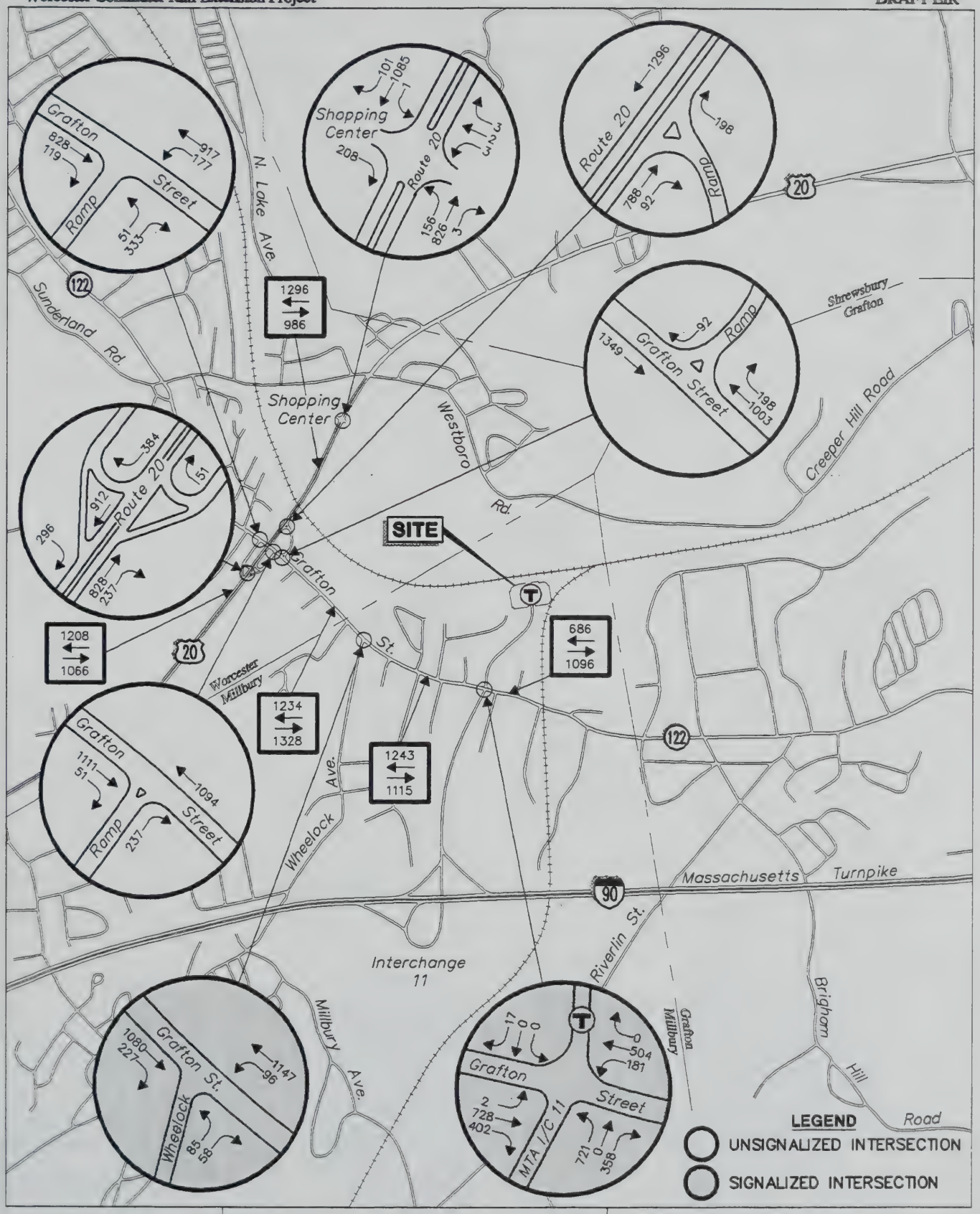
A.M. Peak Hour
7:15 - 8:15 A.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-25



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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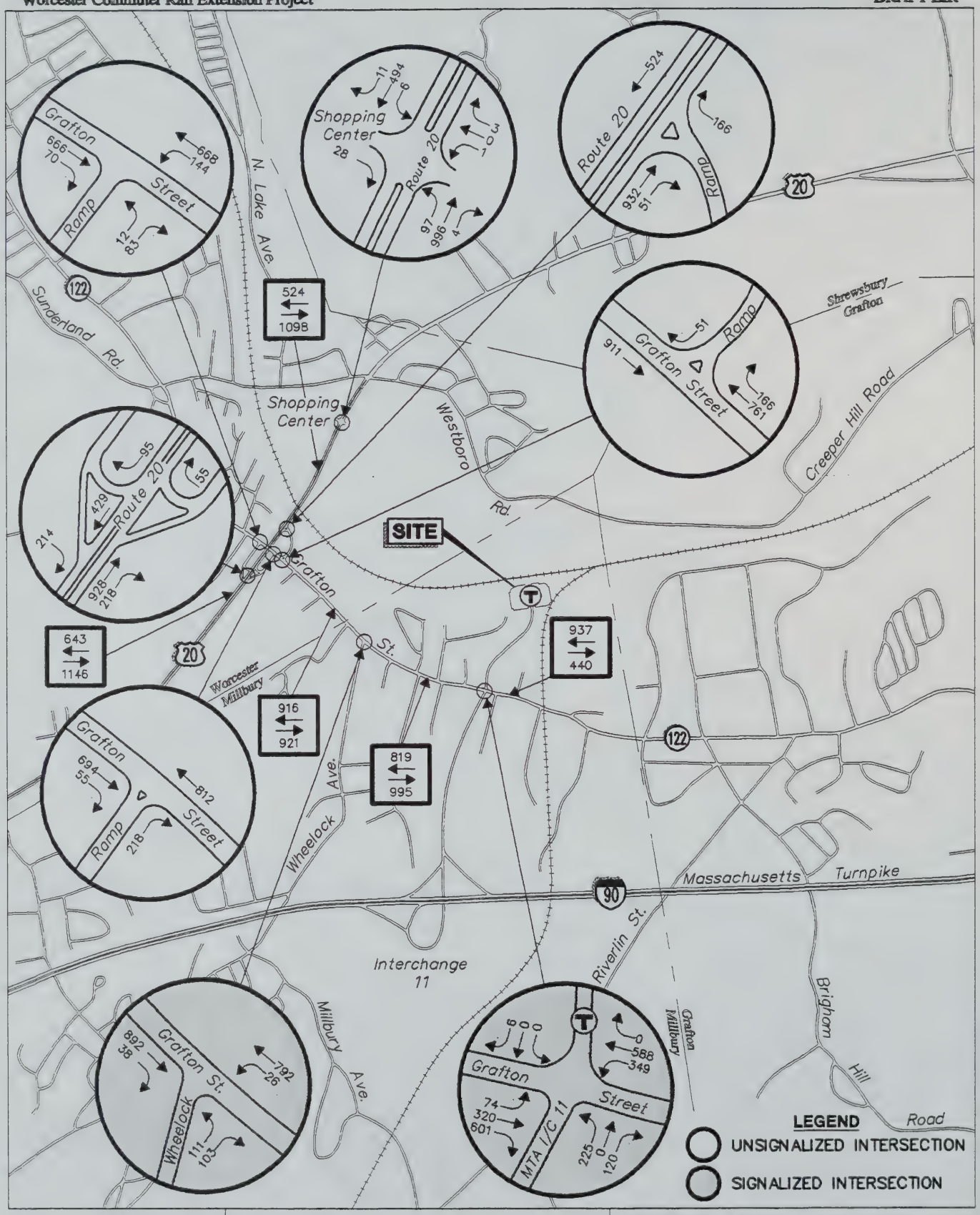
P.M. Peak Hour
5:00 - 6:00 P.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-26



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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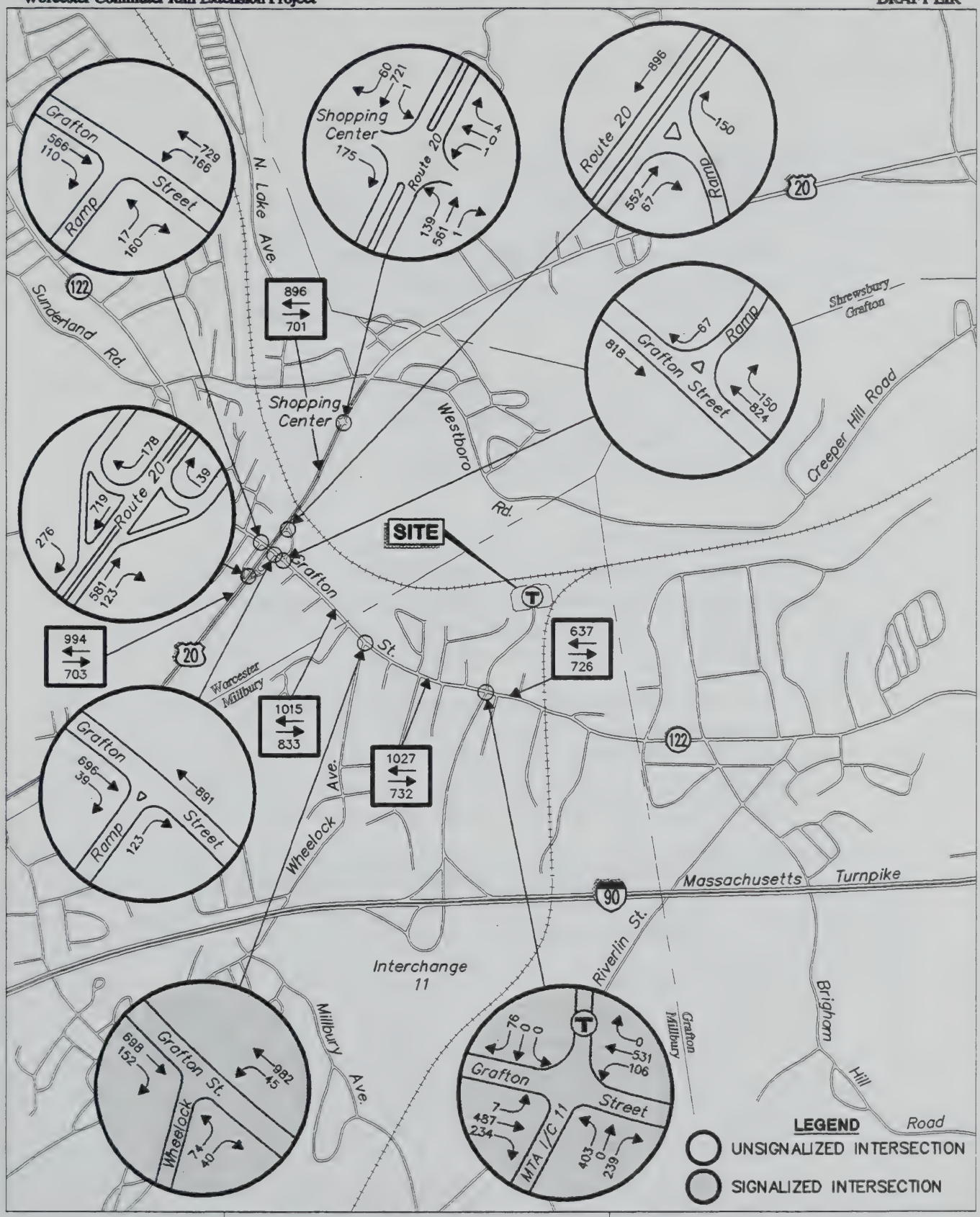
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 122

FIGURE 1.3-28

Year 2001 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only major parameter in the analysis to change from the existing conditions. Roadway geometries, signal phasing, percentages of heavy vehicles, etc. remain unchanged.

The traffic signal timings for the 2001 "No Build" condition and for the 2001 "Build" condition were optimized. Normal maintenance of traffic signals includes the recounting of intersection traffic volumes and the retiming of the traffic signals to account for changes in traffic volumes and travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-24 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours under the 2001 "No Build" and "Build" conditions.

Under the 2001 "No Build" conditions the intersection of Route 122 with Wheelock will operate at overall acceptable level of service ratings with the northbound movement having a LOS "E" in the P.M. peak hour. The intersection of Route 122 with Exit 11 will see its P.M. Peak Hour level of service rating drop to "F" with both the northbound and westbound movement at level of service ratings of "F".

Table 1.3-24 2001 Peak Hour Signalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(6.2)	F(68.7)	B(12.0)	F(66.9)
Eastbound	A(2.7)	C(17.8)	B(5.7)	F(82.9)
Westbound	B(5.2)	F(82.8)	B(10.2)	E(41.2)
Northbound	B(13.2)	F(102.6)	C(24.9)	F(75.4)
Southbound	-	-	C(16.4)	E(44.8)
Route 122 and Wheelock**	A(3.0)	B(10.6)	A(3.0)	B(10.8)
Eastbound	A(2.0)	A(1.5)	A(2.1)	A(1.5)
Westbound	A(2.3)	C(15.5)	A(2.3)	C(15.8)
Northbound	B(9.7)	E(43.8)	B(9.7)	E(43.9)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Under the 2001 "Build" condition the intersection of Route 122 and Wheelock Avenue will continue to operate at an acceptable level of service with only the northbound movement at LOS "E" in the P.M. peak hour. The intersection of Route 122 and Exit 11 will continue to operate at a level of service rating of "F" in the P.M. peak hour. The eastbound and northbound movements will function at a level of service rating of "F", while the westbound and southbound movements will operate at a level of service rating of "E".

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-25 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak traffic hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, the analyzed intersection movements in the "No Build" condition are generally operating at acceptable level of service ratings. Westbound Route 20 traffic turning to Grafton Street and EB Route 20 traffic turning to SB Grafton Street will be at LOS "E" in the A.M. and P.M. peak hours, respectively. Traffic exiting the Mall to Route 20 will operate at LOS "E" in the P.M. peak hour.

The following movements operate at unacceptable LOS "F":

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.
- All the NB traffic from the Truck Business in the P.M. peak hour.

As shown in the table, most of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings. Traffic turning from westbound Route 20 to Grafton Street will operate at LOS "E" in the A.M. peak hour while eastbound Route 20 traffic turning to southbound Grafton Street and traffic turning left from Route 20 into the Mall will function at LOS "E" in the P.M. peak hour.

The following movements operate at unacceptable LOS "F":

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.
- All the NB traffic from the Truck Business in the P.M. peak hour.

No peak hour level of service rating drops will result at the unsignalized intersections from the traffic entering or exiting the commuter rail station, except for left turning traffic from northbound Grafton Street to the WB Route 20 ramp which changes from level of service rating "C" to "D" during the P.M. peak hour.

Table 1.3-25 2001 Peak Hour Unsignalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Millbury and Route 20 West				
LT from NB Millbury	B(325)	C(203)	B(321)	D(199)
LT and RT from Ramp	E(16)	F(-316)	E(14)	F(-317)
SB Millbury and Route 20 East				
RT from Ramp	C(239)	E(18)	C(223)	E(17)
NB Millbury and Route 20 East				
RT from Ramp	C(232)	D(178)	C(229)	D(176)
WB Route 20 and Millbury				
RT from Ramp to WB 20	A(450)	D(153)	A(446)	D(149)
EB Route 20 and SB Millbury				
RT from Ramp to EB 20	B(354)	A(475)	B(354)	A(475)
EB Route 20 and NB Millbury				
RT from Ramp to EB 20	C(292)	B(393)	C(292)	B(393)
Route 20 and Mall				
LT from EB Route 20	B(375)	E(79)	B(375)	E(79)
LT from WB Route 20	D(199)	B(349)	D(199)	B(349)
All from Truck Business	A(421)	F(-7)	A(421)	F(-7)
RT from Mall	A(619)	C(247)	A(619)	C(247)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.3-26 lists the results of the analysis of the A.M. and P.M. peak hours.

As shown in the table, most of the analyzed roadway segments are operating in the "No Build" condition at a peak hour level of service rating of "E". However, not all segments have an unacceptable reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

- Route 122 North of Exit 11 in the A.M. and P.M. Peak Hours.
- Route 122 North of Wheelock in the A.M. and P.M. Peak Hours.

- Route 20 West of Grafton Street in the A.M. and P.M. Peak Hours.

As shown in the table, most of the analyzed roadway segments are operating in the "Build" condition at peak hour level of service rating of "E". However, not all segments have an unacceptable reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

- Route 122 North of Exit 11 in the A.M. and P.M. Peak Hour.
- Route 122 North of Wheelock in the A.M. and P.M. Peak Hours.
- Route 20 West of Grafton Street in the A.M. and P.M. Peak Hours.

No peak hour level of service rating drops will result in the roadway segments from the traffic entering or exiting the commuter rail station.

Table 1.3-26 2001 Peak Hour Road Segment Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(838)	E(652)	E(838)	E(652)
Route 122 North of Exit 11	E(577)	E(220)	E(556)	E(214)
Route 122 North of Wheelock	E(460)	E(22)	E(439)	E(17)
Route 20 West of Route 122	E(153)	E(280)	E(133)	E(275)
EB Route 20 West of Mall	B(1897)	A(2301)	B(1897)	A(2301)
WB Route 20 West of Mall	A(2408)	B(2114)	A(2408)	B(2114)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 Peak Generator Hour Level Of Service

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-27 lists the results of the signalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 2001 "No Build" and "Build" conditions.

Table 1.3-27 2001 Peak Generator Hour Signalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	A(4.7)	B(8.8)	B(9.1)	C(15.5)
Eastbound	A(2.3)	B(7.8)	B(10.3)	C(16.4)
Westbound	A(3.9)	B(8.2)	B(6.8)	B(8.9)
Northbound	B(10.8)	B(10.2)	C(16.8)	C(20.3)
Southbound	-	-	B(14.3)	D(34.0)
Route 122 and Wheelock**	A(2.9)	A(2.3)	A(3.8)	A(2.4)
Eastbound	A(2.1)	A(1.4)	A(1.4)	A(1.4)
Westbound	A(2.2)	A(1.8)	A(1.6)	A(1.9)
Northbound	B(9.4)	C(15.3)	C(22.9)	C(15.3)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Under the 2001 "No Build" conditions both intersections will operate at overall acceptable level of service ratings. None of the movements will see excessive delay.

Under the 2001 "Build" conditions both intersections will continue to operate at overall acceptable level of service ratings. None of the movements will see excessive delay.

The overall level of service rating for the Route 122/Exit 11 intersection drops from "A" to "B" during the A.M. peak generator hour and from "B" to "C" during the P.M. peak generator hour. The overall level of service rating at the Route 122/Wheelock Avenue intersection does not change. The eastbound, westbound and northbound movements at the Route 122/Exit 11 intersection experience minor changes in level of service as does the northbound movement at Wheelock Avenue.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.3-28 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, the analyzed intersection movements in the "No Build" condition are operating at acceptable level of service ratings. Traffic turning from WB

Route 20 to Grafton Street and traffic exiting the truck business are at LOS "E" in the P.M. peak generator hour.

As shown in the table, the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings.

Traffic from WB Route 20 to Grafton Street is a LOS "E" in both peak generator periods, while traffic exiting the truck business is at LOS "E" in the P.M. generator hour.

Peak generator hour level of service ratings generally remain unchanged between the "No Build" and "Build" conditions with the exception of left and right turning traffic from WB Route 20 to Grafton Street during the A.M. peak generator hour ("D" to "E") and right turning traffic from EB Route 20 to SB Grafton Street during the P.M. peak generator hour ("B" to "C").

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.3-29 lists the results of the analysis of the A.M. and P.M. peak generator hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, most of the analyzed roadway segments are operating in the "No Build" condition at the peak hour level of service rating of "E". However, only one segment operates with an unacceptable reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton Street in the A.M. Peak Generator Hour.

As shown in the table, most of the analyzed roadway segments are operating in the "Build" condition at the peak generator hour level of service rating of "E". However, only one segment operates with an unacceptable reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton Street in the A.M. Peak Generator Hour.

Table 1.3-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Millbury and Route 20 West				
LT from NB Millbury	B(351)	B(383)	B(347)	B(366)
LT and RT from Ramp	D(100)	E(70)	E(98)	E(60)
SB Millbury and Route 20 East				
RT from Ramp	C(244)	B(342)	C(226)	B(337)
NB Millbury and Route 20 East				
RT from Ramp	B(332)	B(304)	B(330)	C(296)
WB Route 20 and Millbury				
RT from Ramp to WB 20	A(531)	B(325)	A(527)	B(307)
EB Route 20 and SB Millbury				
RT from Ramp to EB 20	A(448)	A(629)	A(442)	A(627)
EB Route 20 and NB Millbury				
RT from Ramp to EB 20	B(383)	A(549)	B(383)	A(549)
Route 20 and Mall				
LT from EB Route 20	A(454)	C(26)	A(451)	C(260)
LT from WB Route 20	C(267)	A(506)	C(267)	A(506)
All from Truck Business	E(82)	E(72)	E(82)	E(72)
RT from Mall	A(664)	A(417)	A(662)	A(417)

LOS (Reserve Capacity - Vehicles)

No significant peak generator hour level of service rating drops will result in the roadway segments from the traffic entering or exiting the commuter rail station.

Table 1.3-29 2001 Peak Generator Hour Road Segment Level of Service

Millbury (Route 122)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(935)	D(1246)	E(935)	D(1246)
Route 122 North of Exit 11	E(677)	E(762)	E(653)	E(736)
Route 122 North of Wheelock	E(731)	E(716)	E(708)	E(692)
Route 20 West of Route 122	E(419)	E(727)	E(397)	E(690)
EB Route 20 West of Mall	B(2131)	A(2485)	B(2131)	A(2485)
WB Route 20 West of Mall	A(2387)	A(2301)	A(2387)	A(2301)

Year 2001 "Ten Percent of Traffic" Analysis

The Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.3-30 lists the site generated traffic as a percentage of the total traffic at the various intersections and road segments analyzed within the study area during the year 2001 A.M. and P.M. peak hours.

As shown in the Table none of the intersections or road segments analyzed exceed the 10 percent requirement.

Table 1.3-30 2001 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Route 122 and Exit 11	2.9%	0.6%
Route 122 and Wheelock	3.3%	0.7%
Route 122 NB and EB 20 Ramp	2.9%	0.6%
Route 122 SB and EB 20 Ramp	3.0%	0.6%
Route 122 and WB Route 20 Ramp	1.0%	0.5%
Route 20 EB and SB 122 Ramp	2.9%	0.1%
Route 20 EB and NB 122 Ramp	0.0%	0.1%
Route 20 WB and Route 122 Ramp	1.2%	0.7%
Route 20 and Mall and Driveway	0.3%	0.0%
Roadway Segment		
Route 122 South of Exit 11	0.0%	0.0%
Route 122 North of Exit 11	3.6%	0.8%
Route 122 North of Wheelock	2.9%	0.6%
Route 20 West of Route 122	2.2%	0.5%
Route 20 West of Mall	0.3%	0.1%

Site generated traffic as a percentage of total traffic

Summary of Findings

The basic findings of the traffic analysis for the Millbury Commuter Rail Station with access from Route 122, are that generally the streets and intersections within the study area operate acceptably in the "No Build" and "Build" condition.

Traffic turning from WB Route 20 to Grafton Street operates at LOS "F" in the existing and "No Build" conditions, particularly in the P.M. peak periods. Since little if any station generated traffic will be added to this movement, construction of the proposed rail station will not impact existing conditions for this movement.

The intersection of Grafton Street and Exit 11 is expected to deteriorate to LOS "F" by the year 2001 in the P.M. Peak hour "No Build" condition. This is due to normal background traffic growth and will occur with or without construction of the proposed station. Some improvements, including a left turn lane for SB Grafton Street

and new signal timing and phasing, are proposed to accommodate traffic entering and exiting the station.

In summary, while general improvements to increase capacity are warranted on both Route 122 and Route 20, traffic generated by the proposed station will not adversely impact the study area roadways.

1.4 Millbury Station Route 20 Access Station

Project Introduction

The proposed Millbury Commuter Rail Station Alternative (accessed from Route 20) will be located in the northerly corner of the Town of Millbury, southeast of the Worcester town line and north of the railroad tracks. Access to the site will be gained from the Southwest Cutoff/Route 20. The proposed site includes several industrial zoned parcels.

This site was selected by the Town of Millbury's Board of Selectmen as an alternative to the site with access from Route 122.

The proposed station would consist of two 800 foot long low level platforms, with a 45 foot long mini-high platform for handicapped access, a pedestrian overpass, a drop-off area for Kiss'n'Ride patrons, adequate lighting for public safety, and landscaping. A commuter parking lot of 300 spaces would be constructed in conjunction with the rail station. Access to the station's parking lot would be gained via a long access road connecting to Route 20 at a point opposite the shopping mall parking lot.

Study Area

The study area for assessing the traffic impacts of this station focused on the roadways which are anticipated to be used as the major access routes. These roadways include:

- Grafton Street, State Route 122
- Southwest Cutoff, U.S. Route 20

Both of these roads are owned and maintained by the Massachusetts Highway Department.

Grafton Street, State Route 122 is a 40 foot wide two lane road. The Southwest Cutoff, U.S. Route 20 begins in the southwestern part of this study area as a 40 foot wide two lane road. Just west of Grafton Street U.S. Route 20 becomes a four lane divided highway as it passes under Grafton Street and the Conrail Tracks. The four lane divided highway extends for approximately ¼ of a mile before changing into a four lane, undivided highway, extending into the Town of Shrewsbury.

The intersections analyzed within the study area are controlled by stop signs or traffic signals.

Most of the commuters who are expected to use this station are believed to be currently accessing the Mass Pike at Exit 11 to travel to downtown Boston. Commuters from the towns of Charlton or Oxford who will use this station are believed to be accessing the Mass Pike at Exit 10 in Auburn.

Data Collection

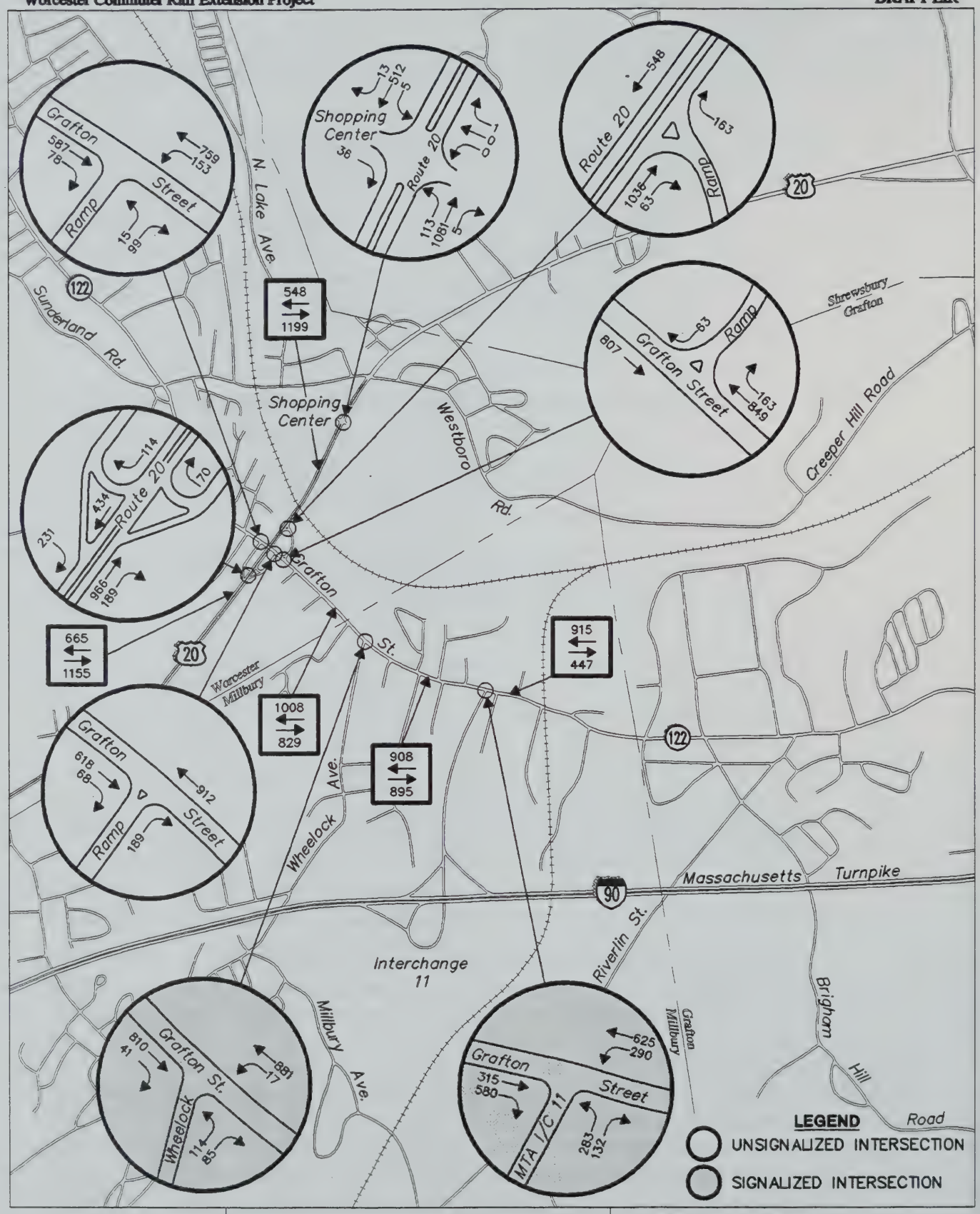
To assess the existing transportation environment, a traffic data collection program was performed from September of 1992 to May of 1993. Data items necessary for the operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing, and the geometric configuration of roadway links and intersections.

Intersection turning movement counts used for the existing conditions analysis, were performed at the following intersections on the dates indicated:

	A.M.	P.M.
Grafton Street with Exit 11 of the Mass Pike	05-11-93	05-11-93
Grafton Street with Wheelock Ave.	10-13-92	10-08-92
Northbound Grafton Street with the Ramp to Eastbound U.S. 20	05-19-93	05-19-93
Southbound Grafton Street with the Ramp to Eastbound U.S. 20	05-19-93	05-19-93
Grafton Road with the Ramp to Westbound U.S. 20	05-18-93	05-18-93
U.S. Route 20 with the Mall and driveway to businesses	11-19-93	09-01-92
Eastbound U.S. 20 with the Ramp to Southbound Grafton Street	05-19-93	05-19-93
Eastbound U.S. 20 with the Ramp to Northbound Grafton Street	05-19-93	05-19-93
Westbound U.S. 20 with the Ramp to Grafton Road	05-18-93	05-18-93

Vehicle turning movement counts were observed and recorded from 6:00 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the intersection peak hour volumes and the volumes during the projected commuter rail station peak generator hour.

Vehicles were classified into two categories: cars and trucks or busses. Volumes were recorded in the standard 15 minute intervals to allow for determination of the peak hours and calculation of the peak hour factor. The 1992 A.M. peak hour traffic volumes are shown in Figure 1.4-1, and the 1992 P.M. peak hour traffic volumes are shown in Figure 1.4-2. The 1992 A.M. peak generator hour traffic volumes are shown in Figure 1.4-3, and the 1992 P.M. peak generator hour traffic volumes are shown in Figure 1.4-4.



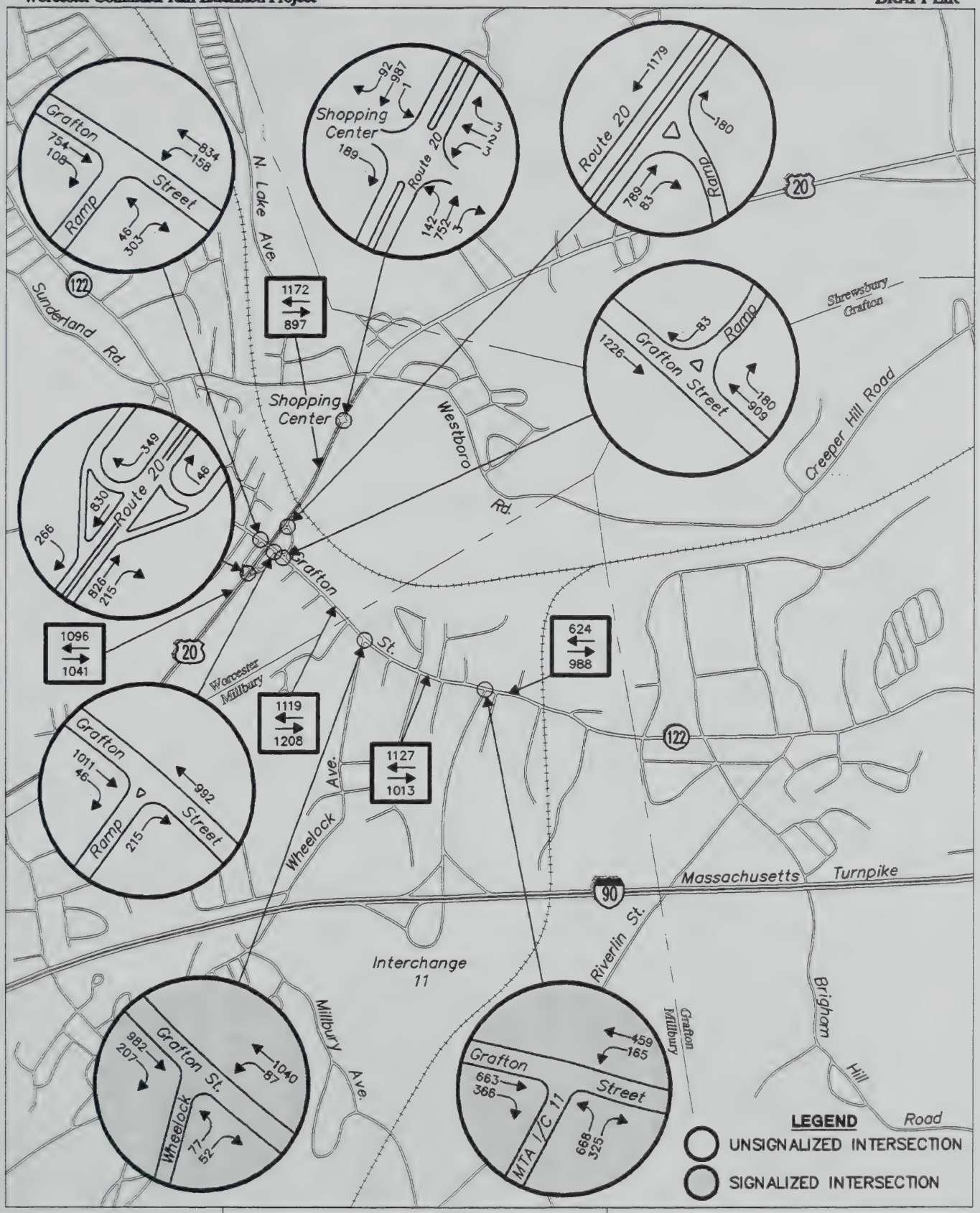
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:15 - 8:15 A.M.
1992 Existing Conditions
Millbury Station - Route 20

FIGURE 1.4-1

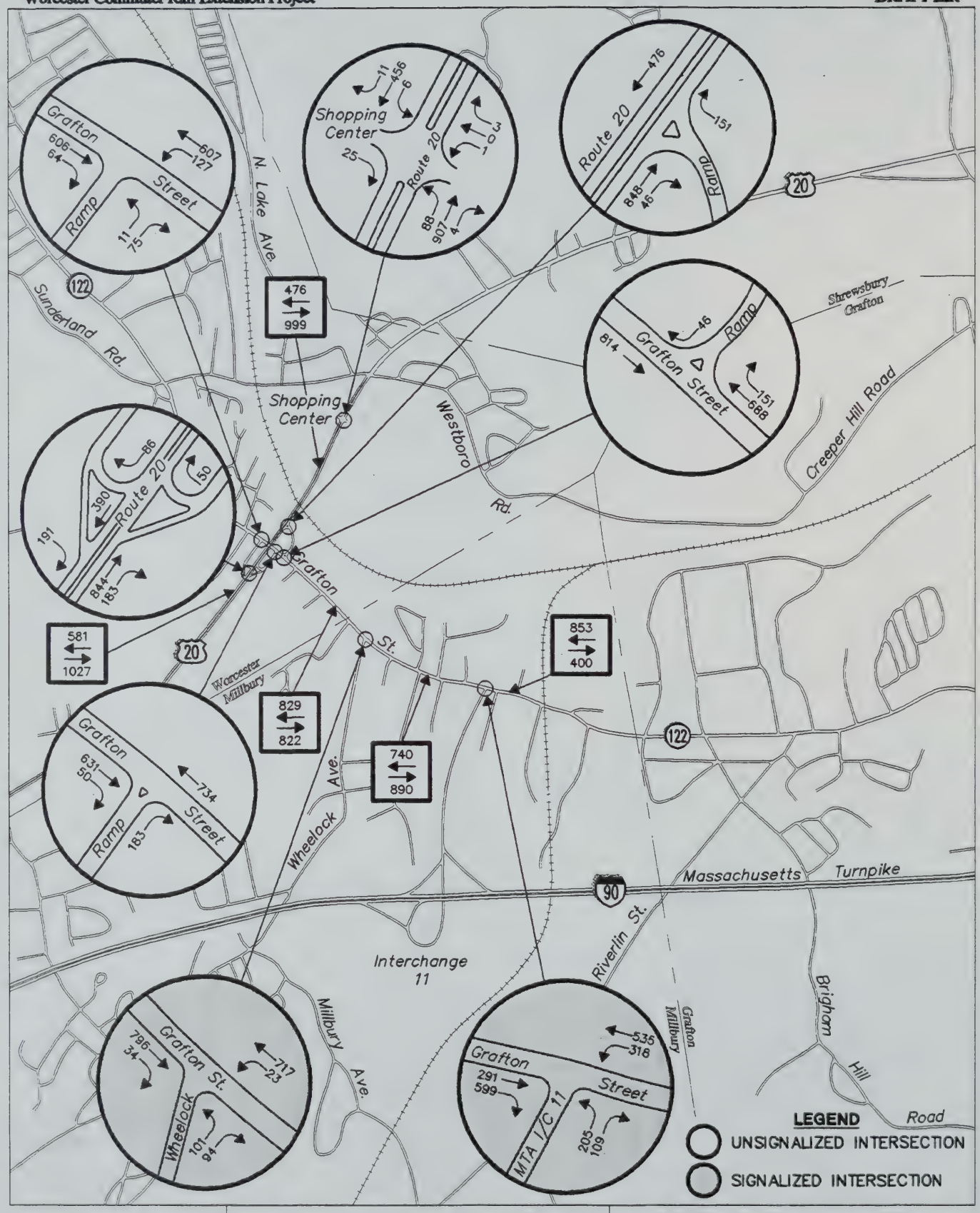


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1992 Existing Conditions
Millbury Station - Route 20

FIGURE 1.4-2



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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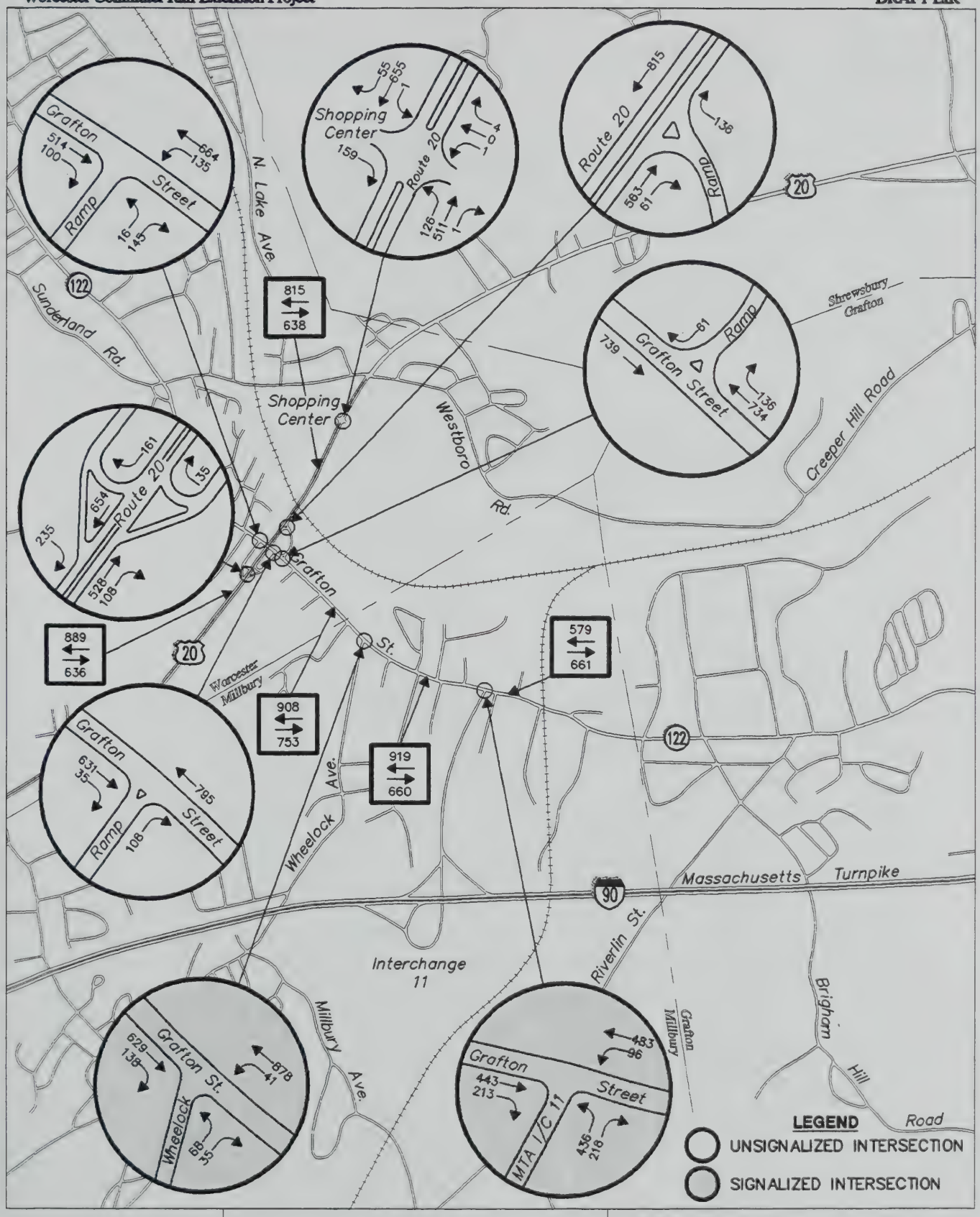
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1992 Existing Conditions
Millbury Station - Route 20

FIGURE 1.4-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1992 Existing Conditions
Millbury Station - Route 20

FIGURE 1.4-4

Traffic signal phasing and timings are typically required for the analysis of signalized intersection operations. The existing traffic signals within the study area are traffic actuated. The phasing patterns were observed in the field. The current signal timings were not obtained from the Massachusetts Highway Department (MHD), instead the optimization routine of "CINCH" was used to estimate the existing or future conditions. This was done because the districts within the MHD have personnel assigned to change the traffic signal timings of the signals that they own and maintain to fit the current traffic patterns.

Intersection geometric configurations were determined through field observations. Geometric elements such as number and use of travel or intersection lanes, lane widths, and roadway grades which are required for operational analysis were field measured or estimated.

The field data sheets for the counts are available for review at the MBTA or MEPA Office.

Year 1992 Existing Conditions

Signalized Intersections

The existing signalized intersections were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The micro-computer software program "CINCH", developed by the Central Transportation Planning Staff (CTPS) was used for the intersection analysis. This program automates the analysis procedures of the HCM.

Grafton Street/Exit 11 Intersection

The intersection of Grafton Street with Exit 11 is a "T" intersection. The intersection is controlled by a two phase traffic actuated signal. The traffic turning right from southbound Grafton Street to the Turnpike or turning right from the Turnpike to southbound Grafton Street has what is termed as a free right turn, that is the right turning traffic uses a lane separated from the intersection and the movement is not controlled by the traffic signals. Since the right turning volumes are not controlled by the traffic signal they are not included in the analysis.

Grafton Street/Wheelock Avenue Intersection

The intersection of Grafton Street with Wheelock Avenue is a "T" type intersection. The intersection is controlled by a two phase traffic actuated signal.

Table 1.4-1 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours. As shown in the table, both the Grafton Road/Exit 11 intersection and the Grafton Road/Wheelock Avenue intersections are operating at acceptable peak hour levels of service. The northbound approach from the Exit 11 ramp operates at LOS "E" in the P.M. peak hour.

Table 1.4-1 1992 Existing Signalized Intersection Level of Service

Millbury (Route 20)	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(5.8)	D(33.2)	B(5.2)	B(9.8)
Eastbound	A(3.2)	C(15.7)	A(3.2)	B(9.5)
Westbound	A(4.9)	C(21.7)	A(4.8)	B(9.6)
Northbound	B(10.9)	E(59.5)	B(9.2)	B(10.3)
Route 122 and Wheelock**	A(4.0)	B(6.0)	A(4.0)	A(2.6)
Eastbound	A(3.0)	A(2.4)	A(3.1)	A(1.8)
Westbound	A(3.3)	B(8.4)	A(3.2)	A(2.2)
Northbound	B(11.4)	B(14.3)	B(11.2)	B(13.4)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Analysis was also performed for the peak generator hours for the site, the A.M. or P.M. hour when the highest traffic volumes are entering or exiting the site. A detailed discussion of the determination of the peak generator hours is contained in the Trip Distribution And Assignment Section of this report.

The results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.4-1. As shown in the Table, both the Grafton Road/Exit 11 intersection and the Grafton Road/Wheelock Avenue intersection are operating at acceptable peak generator hour levels of service. All of the individual directional movements are operating at acceptable levels of service.

Unsignalized Intersections

The unsignalized intersections were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The micro-computer software program "CINCH" was used to perform the analysis. As with the signalized intersections, the A.M. and P.M. peak hours and peak generator hours were analyzed.

As opposed to signalized intersections, the level of service rating for unsignalized intersections are stated in terms of reserve capacity. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. Another important difference between signalized and unsignalized analysis is there is no overall level of service rating for unsignalized intersections. A detailed description of level of service is provided in Section 1.1 of this report.

Grafton Street/Westbound Route 20 Ramp

The Ramp from or to Route 20 westbound intersects the southbound side of Grafton Street at 90 degrees forming a "T" intersection. The traffic from westbound Route 20 is controlled from turning left or right onto Grafton Street by a stop sign.

Grafton Street Southbound/Eastbound Route 20 Ramp

The Ramp from or to Route 20 eastbound intersects the southbound side of Grafton Street at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the southbound through movement, the eastbound right turn movement from Grafton Street, and the southbound right turn movement from Route 20. The eastbound right turn movement is controlled by a stop sign.

Grafton Street Northbound/Eastbound Route 20 Ramp

The Ramp from or to Route 20 eastbound intersects the northbound side of Grafton Street at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the northbound through movement, the eastbound right turn movement from Grafton Street, and the northbound right turn movement from eastbound Route 20. The northbound right turn movement is controlled by a stop sign.

Route 20 Westbound/Grafton Street Ramp

The ramp to or from Grafton Street intersects the westbound side of Route 20 at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the westbound through movement, the right turn movement from Route 20, and the westbound right turn movement from Grafton Street. The westbound right turn movement is controlled by a stop sign.

Route 20 Eastbound/Southbound Grafton Street Ramp

The ramp to or from southbound Grafton Street intersects the eastbound side of Route 20 at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the eastbound through movement, the southbound right turn movement from Grafton Street, and the eastbound right turn movement from southbound Grafton Street. The eastbound right turn movement is controlled by a stop sign.

Route 20 Eastbound/Northbound Grafton Street Ramp

The ramp to or from northbound Grafton Street intersects the eastbound side of Route 20 at 90 degrees forming a "T" intersection. Turning traffic is limited to right turns only, thus there are only three movements allowed. They are the eastbound through movement, the right turn movement from Route 20, and the eastbound right turn movement from northbound Grafton Street. The eastbound right turn movement is controlled by a stop sign.

Route 20/Mall and Truck Business Driveways

Route 20 intersects the driveways to the Mall and the Truck Business at a 90 degree angle forming a cross road intersection. There are left turning lanes and two through lanes for the eastbound or westbound Route 20 traffic. There is also right turning deceleration lane to access the Mall and a right turning acceleration lane for access to Route 20 from the Mall. Access from the Mall to Route 20 is limited to a right turn only onto westbound Route 20 and is controlled by a stop sign. Access to Route 20 from the Truck Business is uncontrolled but exiting traffic behaved as if it was stop sign controlled. In the "Build" analysis it is assumed that this intersection will be controlled by traffic signals which are coordinated with the existing traffic signals at the intersection of Route 20 with Sunderland Road and Westborough Street.

The results of the A.M. and P.M. peak hour analysis of the unsignalized intersections are found in Table 1.4-2. As shown in the table, most of the analyzed intersection movements are operating at acceptable level of service ratings.

In the A.M. peak traffic hour the traffic turning left or right from westbound Route 20 to Grafton St. is LOS "E". The traffic turning right from eastbound Route 20 to SB Grafton St. is at LOS "E" in the P.M. peak hour.

Table 1.4-2 1992 Unsignalized Intersection Level of Service

Millbury (Route 20)	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(383)	C(262)	A(407)	A(439)
LT and RT from Ramp	E(77)	F(-236)	D(159)	D(136)
SB Grafton and Route 20 East				
RT from Ramp	C(299)	E(80)	B(304)	B(394)
NB Grafton and Route 20 East				
RT from Ramp	C(280)	C(229)	B(380)	B(352)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(499)	C(217)	A(574)	B(381)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(423)	A(489)	A(488)	A(661)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(345)	A(415)	A(432)	A(561)
Route 20 and Mall				
LT from EB Route 20	A(422)	D(132)	A(489)	B(313)
LT from WB Route 20	C(235)	B(388)	B(305)	A(541)
All from Truck Business	A(456)	F(-2)	D(113)	D(111)
RT from Mall	A(646)	B(300)	A(684)	A(461)

LOS (Reserve Capacity - Vehicles)

The movements operating at unacceptable LOS "F" are right turns from eastbound Route 20 to southbound Grafton Street in the P.M. peak hour and all traffic from the truck business in the P.M. peak hour.

The results of the A.M. and P.M. peak generator hour analysis of the unsignalized intersections are also listed in Table 1.4-2. As shown in the table, all of the intersection movements analyzed are operating at acceptable level of service ratings.

Roadway Segments

The average daily traffic (ADT) and average weekday traffic (AWDT) are shown on Figure 1.4-5. The roadway segments were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The micro-computer software program "Highway Capacity Software (HCS)" version 1.5 was used to perform the analysis. As with the signalized and unsignalized intersections, the A.M. and P.M. peak hours and peak generator hours were analyzed.

The results of the A.M. and P.M. peak hour analysis of the roadway segments are found in Tables 1.4-3. As shown in the table many of the analyzed roadway segments are operating at the level of service rating of "E". However, most of the segments analyzed operate within the acceptable range of reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

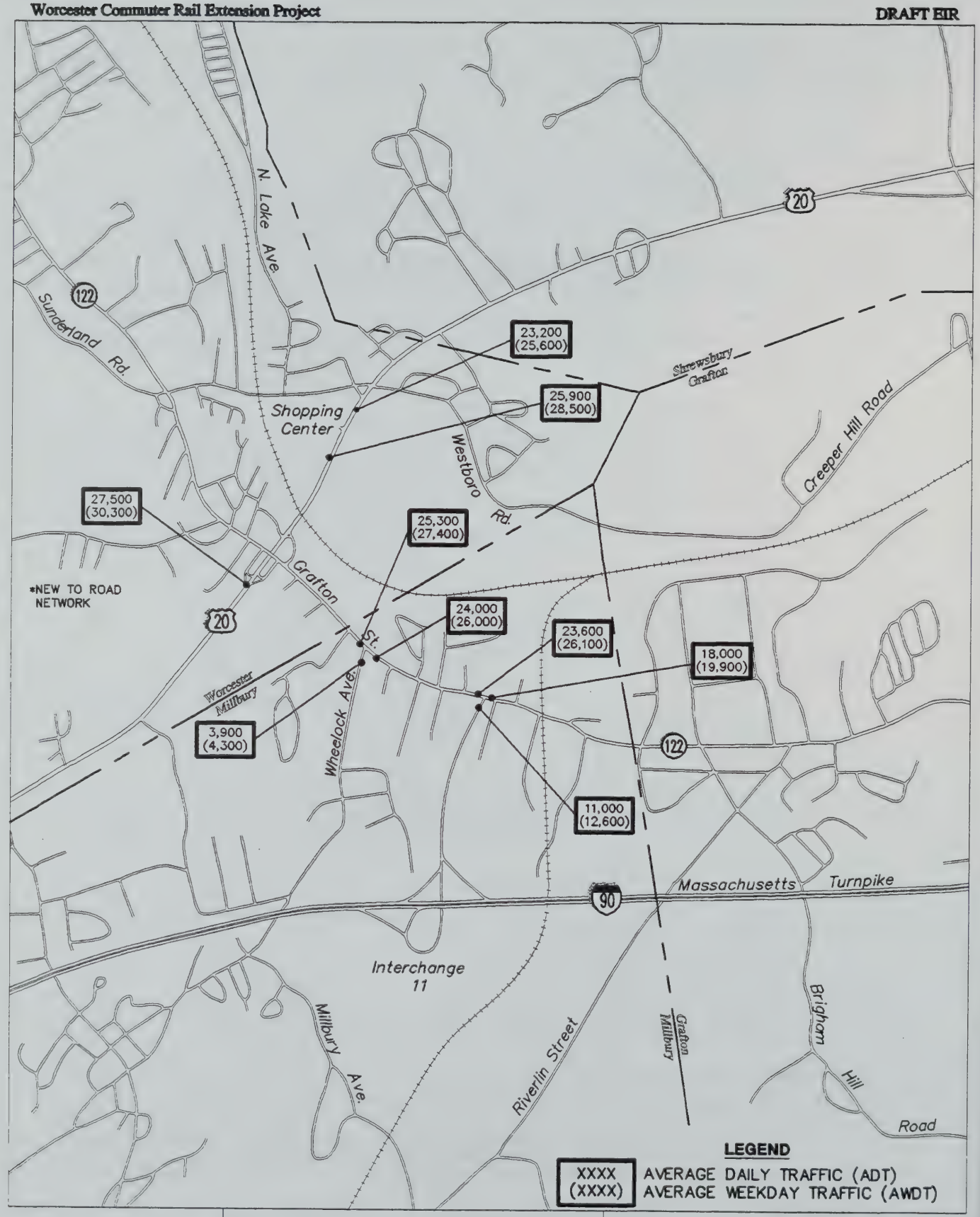
- Route 122 North of Exit 11 in the P.M. Peak Hour
- Route 122 North of Wheelock in the P.M. Peak Hour
- Route 20 West of Grafton St. in the A.M. and P.M. Peak Hours

As shown in the table, during the peak generator hours, half of the analyzed roadway segments are operating at level of service rating of "E", with all but one in the acceptable range of reserve capacity.

Table 1.4-3 1992 Existing Road Segment Level of Service

Millbury (Route 20)	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(964)	E(845)	D(1067)	D(1377)
Route 122 North of Exit 11	E(744)	E(441)	E(846)	E(926)
Route 122 North of Wheelock	E(628)	E(262)	E(904)	E(889)
Route 20 West of Route 122	E(417)	E(450)	E(587)	E(886)
EB Route 20 West of Mall	B(2042)	A(2425)	A(2224)	A(2552)
WB Route 20 West of Mall	A(2496)	B(2177)	A(2499)	A(2445)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

1992 Average Daily Traffic and 1992 Average Weekday Traffic Millbury, MA - Route 20

FIGURE 1.4-5

Safety Concerns And Accident History

The Millbury Police Department was contacted on June 21, 1994, to determine the existence and location of any safety concerns or high accident intersections. Chief Handfield indicated that no existing serious safety concerns or high accident locations currently exist within the MBTA study area in the Town of Millbury. Preliminary analysis of accident data supplied by the Department supports this conclusion.

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, the year 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments within the study area.
- Increases in existing traffic volumes due to population growth and development within the vicinity of, but outside of the study area.

Through discussions with the Town of Millbury, it was determined that no major new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of the 1996 "No Build" traffic volumes.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. The Massachusetts Highway Department compiles and publishes traffic volume data, through a statewide traffic counting program. One count site in Millbury is published in the state's traffic volume data. The site on Route 122 experienced a growth rate of negative 0.1 percent over the last few years. The trend station for this area is located on Route 9. The data from this station showed an average growth rate of negative 0.1 percent over the last 3 years.

This negative growth rate is most likely due to the economic downturn experienced throughout the region over the past years. Economic indicators point towards a very slow recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

To account for this potentially low growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5 percent per year was applied to the 1992 Existing condition traffic volumes to obtain the 1996 "No Build" traffic volumes. Figure 1.4-6 shows the projected A.M. peak hour traffic volumes, and Figure 1.4-7 shows the projected P.M. peak hour traffic volumes. Figure 1.4-8 shows the projected A.M. peak generator hour traffic volumes, and Figure 1.4-9 shows the projected P.M. peak generator hour traffic volumes.

The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to Worcester.

Proposed Traffic Control Change

During the collection of the traffic data at the intersection of Route 20 with the Mall's driveway and the Truck Business's driveway, it was noted that despite the signing and traffic island instructing vehicles to make a right turn only onto westbound Route 20 from the Mall, some vehicles presently make left turns. Even more vehicles turned right, went a few hundred feet, and turned left onto private property and immediately came out of the property making a right turn to eastbound Route 20.

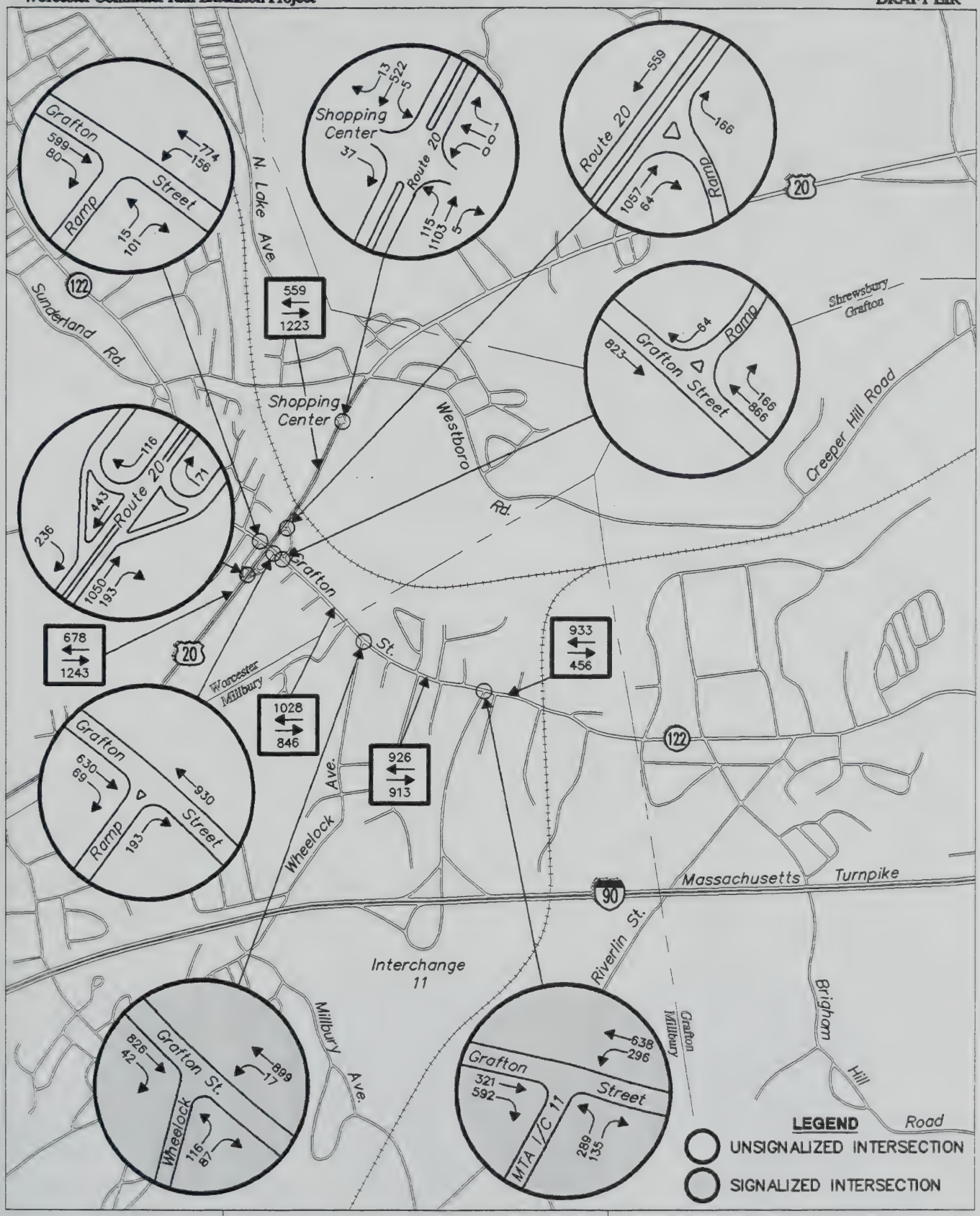
A check of the peak hour traffic signal warrant for the volumes counted in the P.M. peak hour and in the P.M. peak generator hour showed the volume requirements of this warrant being met during both hours.

Since most of the commuters from the Millbury Station will desire to make a left turn when exiting the station, it is proposed that this intersection be signalized and coordinated with the traffic signals at the intersection of Route 20 with Sunderland Road and Westborough Street. Analysis of the 1996 "Build" condition assumed signalization of this intersection.

Year 1996 Trip Generation And Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 commuters are expected to utilize the railroad for daily round trip commuting into Boston.

In 1996, the proposed Millbury Station is projected to attract a total of 149 daily round trip commuters. Twelve of these patrons would be dropped off at the station. Based upon an average automobile occupancy rate of 1.12, the remaining 137 patrons would result in a parking demand of 122 parking spaces. This leaves 178 parking spaces empty in the build year.



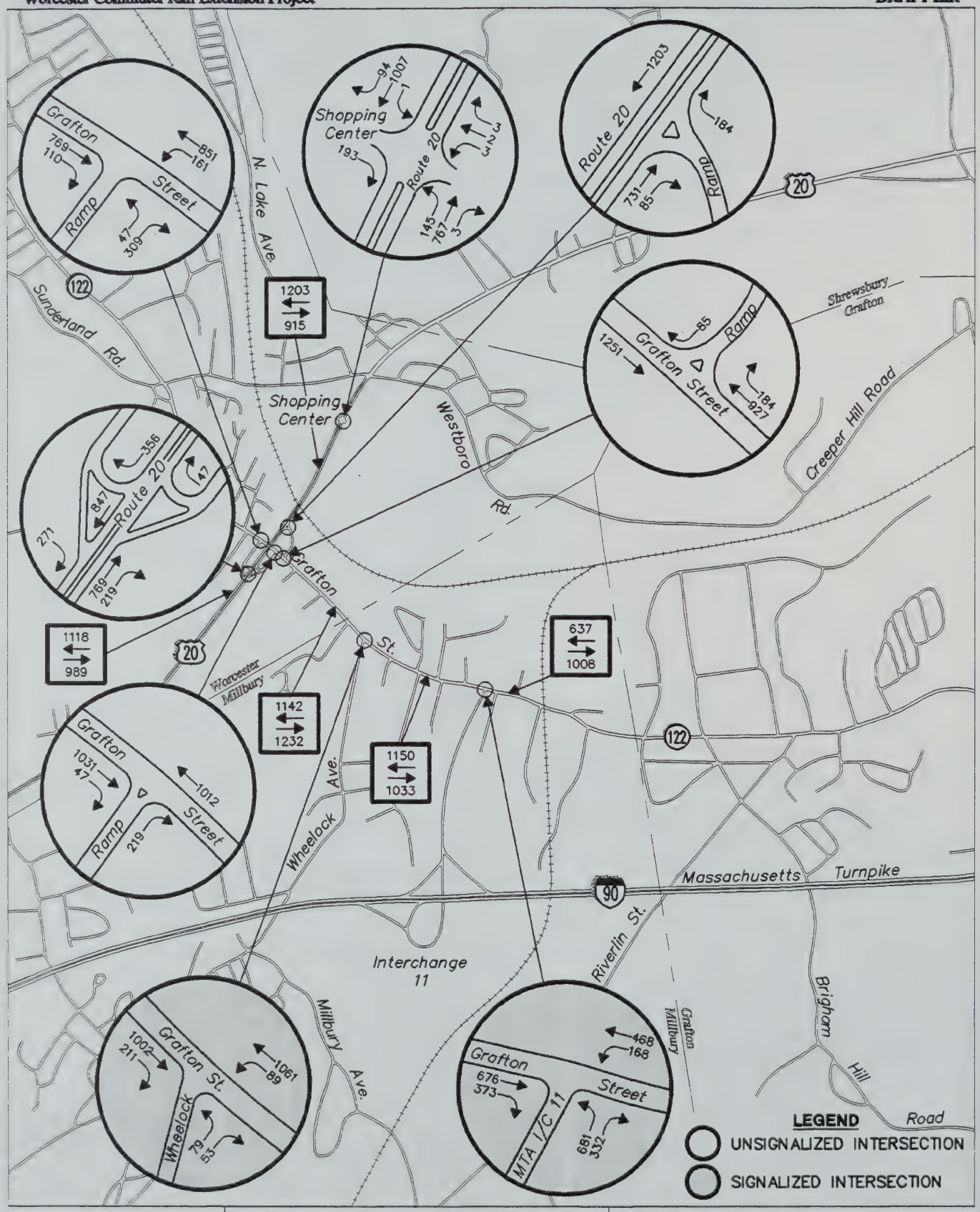
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:15 - 8:15 A.M.
1996 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-6



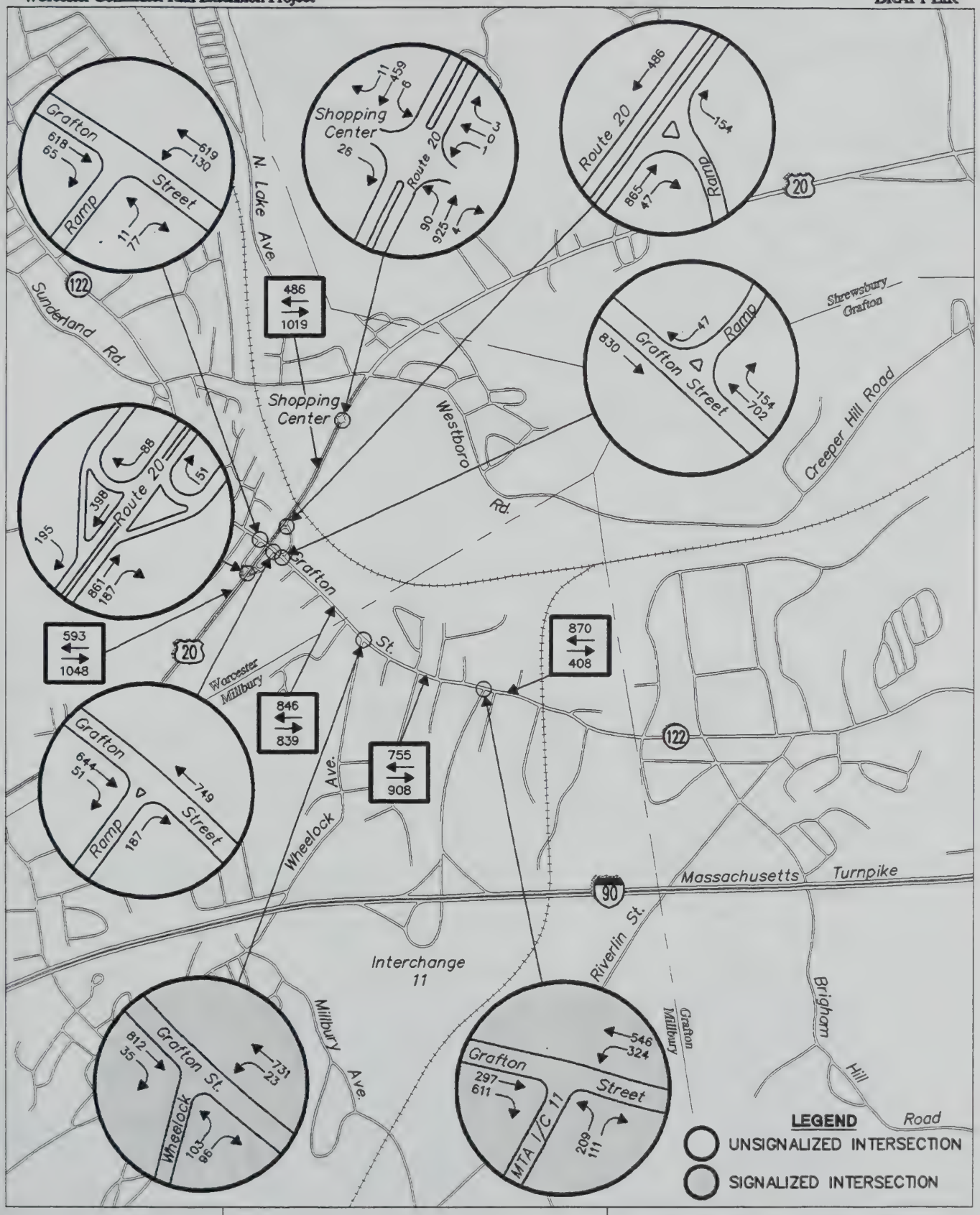
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-7



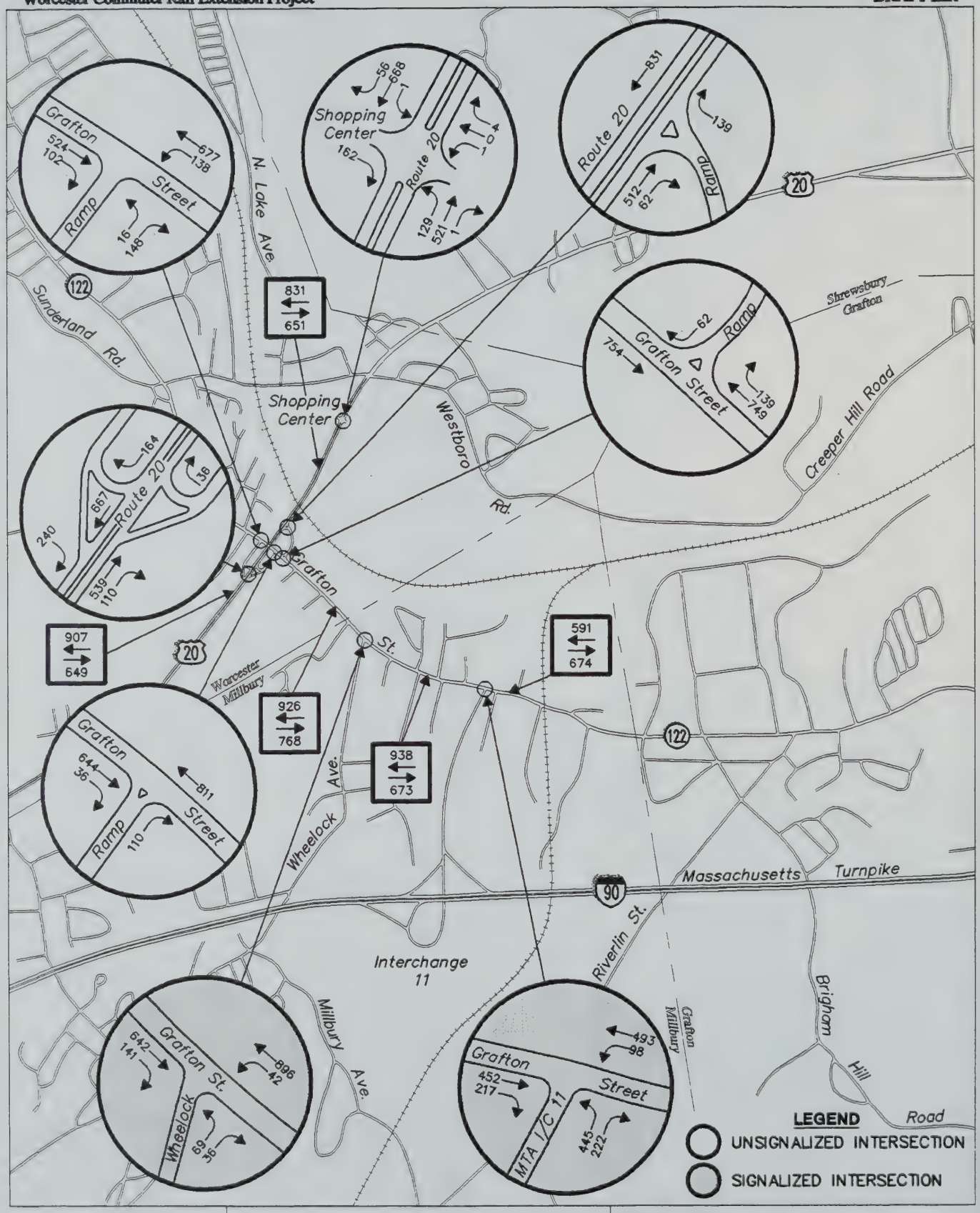
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 NO BUILD
Millbury Station - Route 22

FIGURE 1.4-8



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1996 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-9

The patrons who are projected to use the Millbury Station are expected to reside in the Towns of Auburn, Charlton, Millbury, Oxford, and the City of Worcester. The number of patrons who originate from each Town are shown in Table 1.4-4. The ridership has been adjusted to reflect peak period usage, which is 94% of total daily demand.

These ridership levels are expected to occur shortly after completion of the Millbury Station, therefore, these projections were used in the determination of the 1996 "Build" condition.

Table 1.4-4 Projected Patrons of Millbury Station - Year 1996

Town	Riders*
Auburn	25
Charlton	16
Millbury	24
Oxford	16
Worcester	58
TOTAL	**139**

* *Adjusted for peak period demand*

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the usual starts of the business day (7:30, 8:00, 8:30, or 9:00) will be more in demand than trains which arrive either earlier or later.

Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the usual close of business (4:30, 5:00, 5:30, or 6:00 P.M.) are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on current ridership per train and the arrival or departure times in Boston of said trains. Details of the development of these equations are presented in Section 1.1.

Table 1.4-5 lists the projected distribution of ridership from the Millbury Station based on the expected arrival time in Boston or departure time from Boston.

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the out of pocket cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time typically results in the A.M. and P.M. peak hours for the site to lie totally or partially out side of the typical peak hour ranges of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

Table 1.4-5 MBTA Ridership Distribution

Inbound Train	Patrons
502A	27
504A	45
506A	45
510	22
TOTAL	**139**
Outbound Train	**Patrons**
515A	19
519	32
521	32
521A	49
523	7
TOTAL	**139**

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Millbury Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Millbury the typical A.M. and P.M. intersection peak hours are from 7:15 to 8:15 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the

peak generator hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 6:00 to 7:00 P.M.

Once the project generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Millbury would utilize eastbound Route 20 or northbound Wheelock Avenue, depending on the location of their residences. Riders originating in towns outside that in which the station is located were assigned to the major roads from their town to the station.

The patrons from Auburn, Charlton, and Oxford would access the station from eastbound U.S. Route 20. The patrons from Worcester would access the station from eastbound Route 20, westbound Route 20, or southbound Route 122. Actual routing was estimated based on the shortest travel time and distance from population centers. Figure 1.4-10 shows the percentage of station related traffic utilizing the study area roadways for the year 1996 "Build" condition.

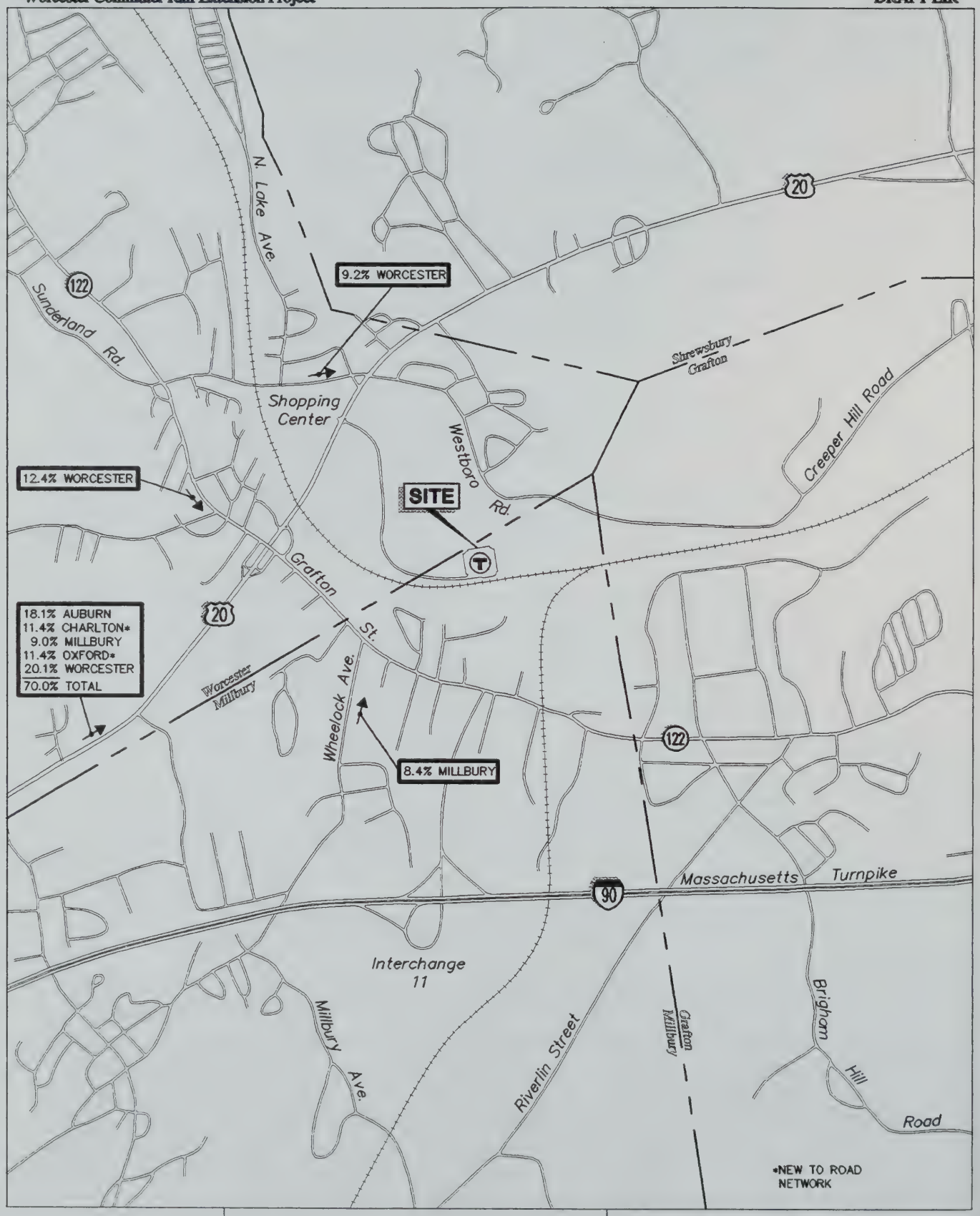
Upon completion of the commuter rail service, commuters will shift from automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along Route 122 and the Mass Pike. Traffic volumes are expected to increase on Route 20 west of Route 122.

Year 1996 "Build" Traffic Volumes

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Millbury rail station.

A portion of the traffic volumes heading to the proposed station would be diverted from the existing travel route to the Mass Pike, which is Grafton Street, Route 122. These existing vehicle trips would not be generated as new trips. The vehicles currently by-passing the site were not assigned to the roadway network as new trips, they are only shown as being diverted from the Mass Pike to the commuter rail site. Figure 1.4-11 shows the projected A.M. peak hour traffic volumes. Figure 1.4-12 shows the projected P.M. peak hour traffic volumes. Figure 1.4-13 shows the projected A.M. peak generator hour traffic volumes. Figure 1.4-14 shows the projected P.M. peak generator hour traffic volumes.

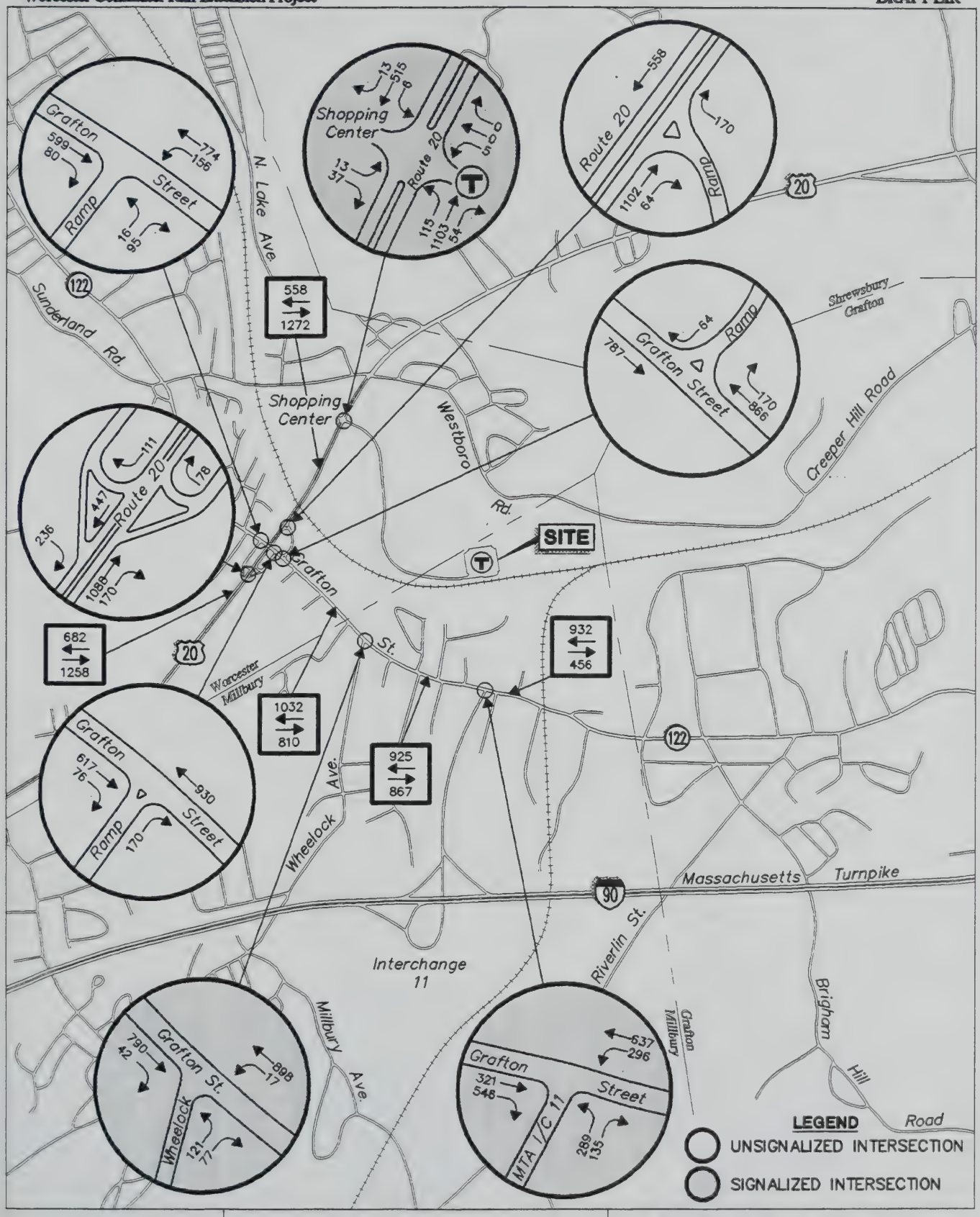


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-10



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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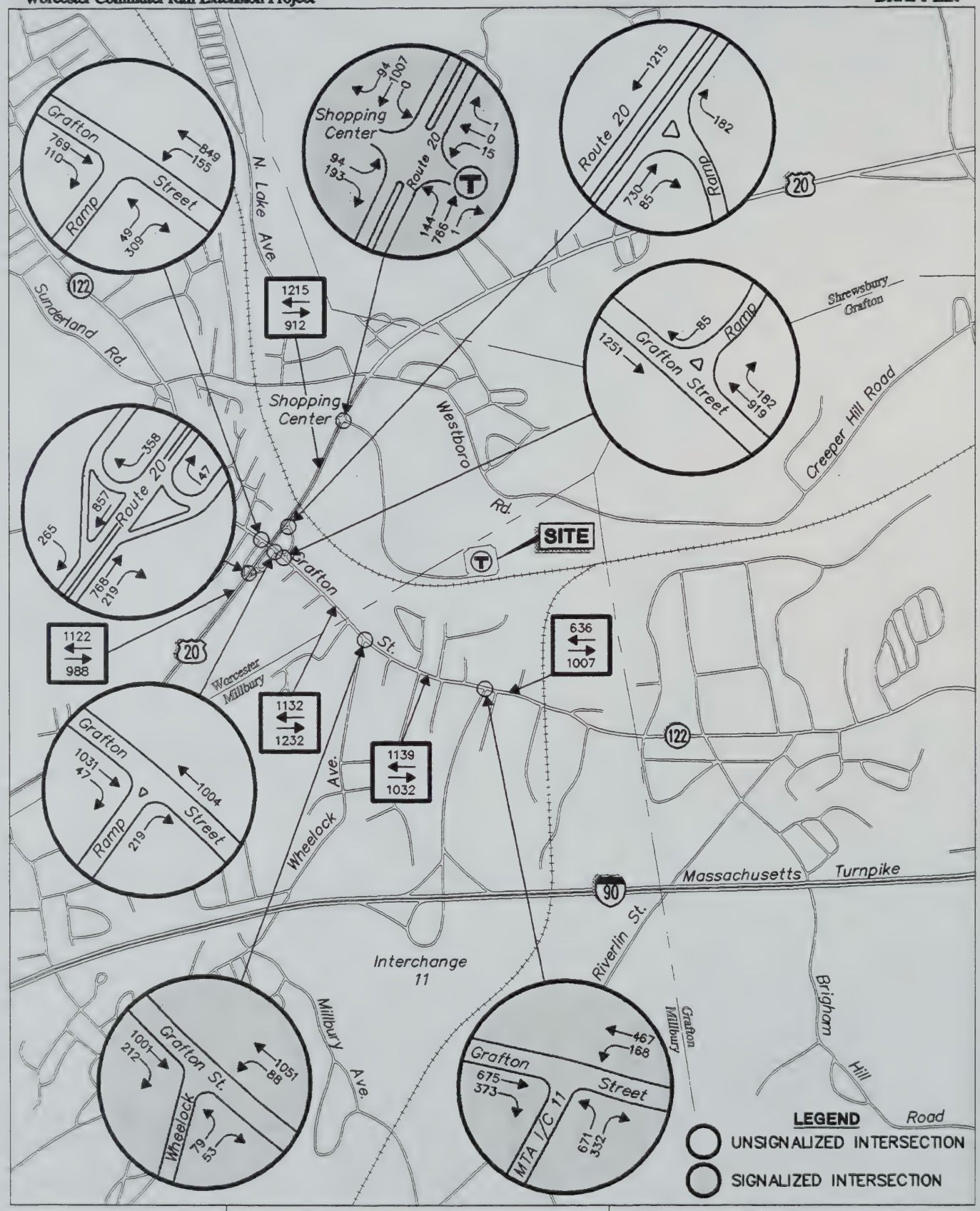
A.M. Peak Hour
7:15 - 8:15 A.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-11

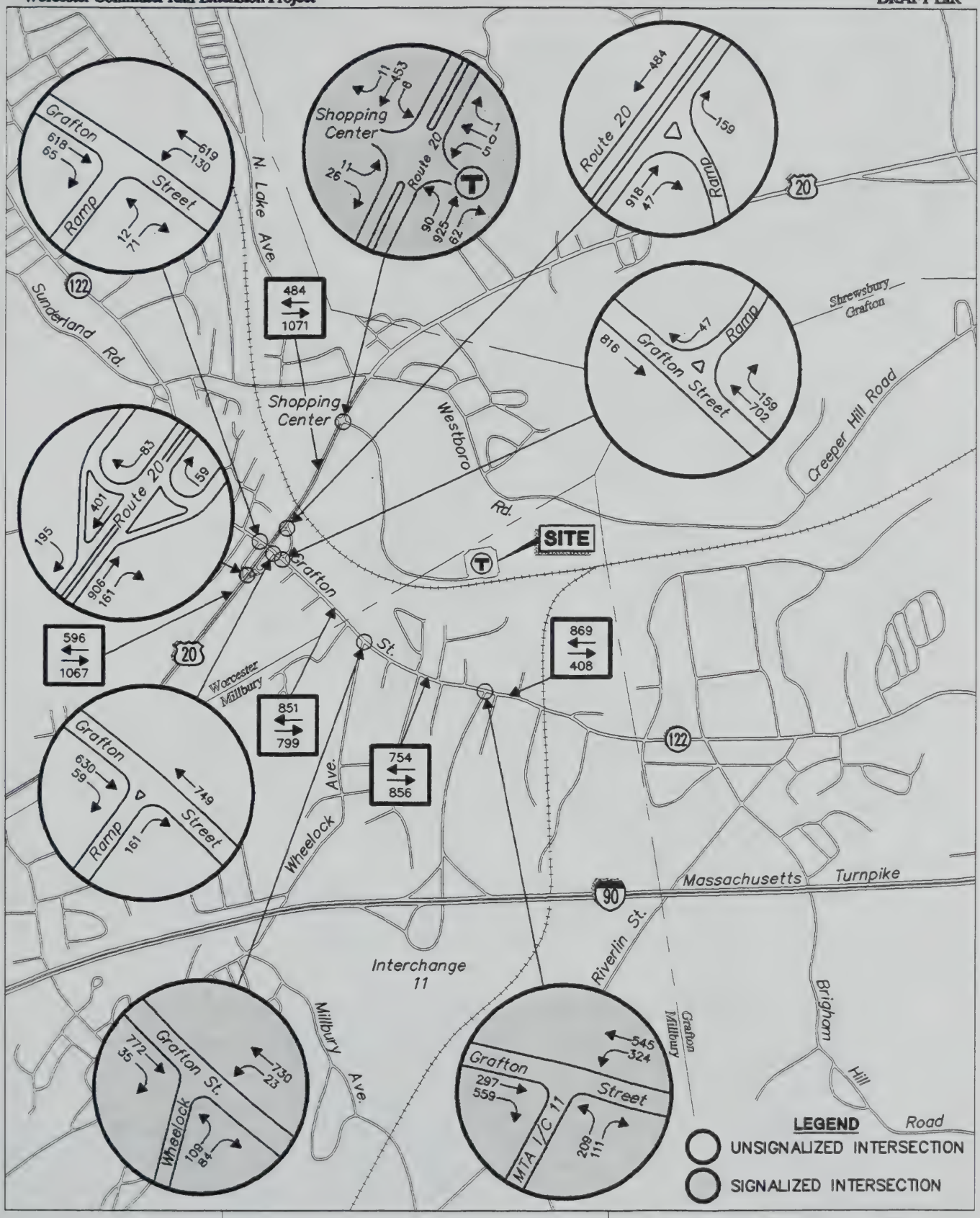


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-12

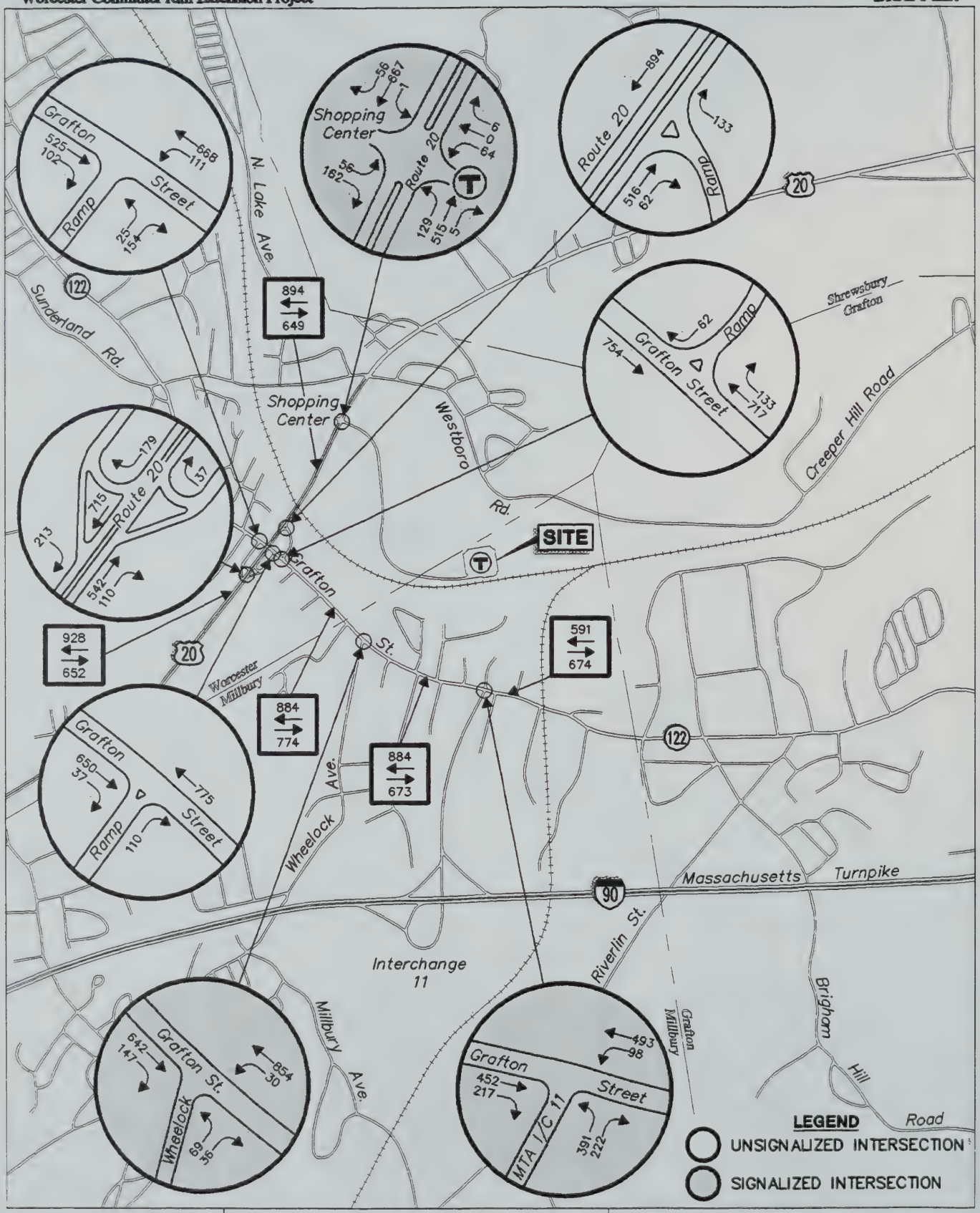


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1996 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-14

Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only major parameter in the analysis to change from the existing conditions. Roadway geometries, signal phasing, percentages of heavy vehicles, etc. remain unchanged.

The traffic signal timings for the 1996 "No Build" condition and for the 1996 "Build" condition were optimized. Normal maintenance of traffic signals includes the recounting of intersection traffic volumes and the retiming of the traffic signals to account for changes in traffic volumes and travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-6 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

Under the 1996 "No Build" conditions both existing intersections will operate at overall acceptable level of service ratings. The northbound movement from the Mass Pike will have a level of service rating of "E" in the P.M. peak hour.

By 1996, it is anticipated that a traffic signal will be installed at the intersection Route 20 and the proposed station access drive.

Under the 1996 "Build" conditions the existing intersections plus the proposed signalized intersection will operate at overall acceptable level of service ratings. As in the "No Build" condition the northbound movement from the Mass Pike will have a level of service rating of "E" in the P.M. peak hour.

No decline in peak hour level of service will result at the signalized intersections from the traffic entering or exiting the commuter rail station.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-7 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

As shown in the table most of the analyzed intersection movements in the "No Build" condition are operating at acceptable level of service ratings. Traffic turning left or right from WB Route 20 to Grafton Street operates at LOS "E" in the A.M. peak hour, while traffic turning right from eastbound Route 20 to southbound Grafton Street operates at LOS "E" in the P.M. peak hour.

The following movements operate at unacceptable LOS "F":

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.
- All the NB traffic from the Truck Business in the P.M. peak hour.

Table 1.4-6 1996 Peak Hour Signalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(5.4)	D(34.6)	B(5.4)	D(32.6)
Eastbound	A(2.6)	C(15.1)	A(2.6)	C(15.1)
Westbound	A(4.4)	D(26.7)	A(4.4)	D(26.4)
Northbound	B(11.2)	E(59.6)	B(11.3)	E(54.7)
Route 122 and Wheelock**	A(2.6)	B(6.0)	A(2.8)	B(5.8)
Eastbound	A(2.0)	A(1.4)	A(1.9)	A(1.4)
Westbound	A(2.1)	B(6.3)	A(2.1)	B(6.0)
Northbound	B(10.2)	D(34.5)	B(9.4)	D(36.5)
Route 20 and Mall**	-	-	B(7.8)	B(12.6)
Eastbound	-	-	B(6.1)	B(10.1)
Westbound	-	-	B(10.2)	B(12.4)
Northbound	-	-	D(26.8)	D(25.0)
Southbound	-	-	D(25.8)	C(20.6)

(LOS) Average Vehicle Stopped Delay in Seconds

*** Optimized signal timings were used for analysis*

Table 1.4-7 1996 Peak Hour Unsignalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(371)	C(250)	B(371)	C(256)
LT and RT from Ramp	E(66)	F(-253)	E(59)	F(-255)
SB Grafton and Route 20 East				
RT from Ramp	C(287)	E(68)	B(318)	E(68)
NB Grafton and Route 20 East				
RT from Ramp	C(270)	C(218)	C(269)	C(222)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(488)	C(204)	A(499)	C(217)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	B(393)	A(507)	B(381)	A(507)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(334)	A(433)	B(315)	A(436)
Route 20 and Mall				
LT from EB Route 20	A(413)	D(121)	-	-
LT from WB Route 20	C(227)	B(380)	-	-
All from Truck Business	A(448)	F(-4)	-	-
RT from Mall	A(641)	C(289)	-	-

LOS (Reverse Capacity - Vehicles)

As shown in the table most of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings. The traffic turning left or right from westbound Route 20 to Grafton Street operates at LOS "E" in the A.M. peak hour, while traffic turning right from eastbound Route 20 to southbound Grafton Street operates at LOS "E" in the P.M. peak hour.

Only the traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour operates at unacceptable LOS "F".

No decline in peak hour level of service will result at the unsignalized intersections from the traffic entering or exiting the commuter rail station.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.4-8 lists the results of the analysis of the A.M. and P.M. peak hours.

As shown in the Table most of the analyzed roadway segments are operating in the "No Build" condition at the peak hour level of service rating of "E". However, all but four of the segments analyzed operate within the range of acceptable reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hour are as follows:

- Route 122 North of Exit 11 in the P.M. Peak Hour
- Route 122 North of Wheelock in the P.M. Peak Hour
- Route 20 West of Grafton St. in the A.M. and P.M. Peak Hour

As shown in the Table most of the analyzed roadway segments are operating in the "Build" condition at peak hour level of service rating of "E". However, all but four of the segments analyzed operate within the range of acceptable reserve capacity. The roadway segments which have an unacceptable reserve capacity in the peak hours are as follows:

- Route 122 North of Exit 11 in the P.M. Peak Hours.
- Route 122 North of Wheelock in the P.M. Peak Hours.
- Route 20 West of Grafton St. in the A.M. and P.M. Peak Hours.

No decline in peak hour level of service rating will result in the roadway segments from the traffic entering or exiting the commuter rail station. The "Build" condition will result in minor reductions in reserve capacity.

Table 1.4-8 1996 Peak Hour Road Segment Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(949)	E(810)	E(936)	E(813)
Route 122 North of Exit 11	E(706)	E(396)	E(724)	E(425)
Route 122 North of Wheelock	E(610)	E(213)	E(607)	E(223)
Route 20 West of Route 122	E(307)	E(449)	E(287)	E(446)
EB Route 20 West of Mall	B(1995)	A(2353)	B(1908)	A(2345)
WB Route 20 West of Mall	A(2383)	B(2139)	A(2542)	B(2068)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Peak Generator Hour Level Of Service

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4.9 lists the results of the signalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 1996 "No Build" and "Build" conditions.

Under the 1996 "No Build" conditions both intersections will operate at overall acceptable level of service ratings. None of the movements will see excessive delay.

Under the 1996 "Build" conditions all three intersections will operate at overall acceptable level of service ratings in the peak generator hour. None of the movements will see excessive delay.

No decline in peak hour level of service rating will result at the signalized intersections from the traffic entering or exiting the commuter rail station with the exception of the northbound movement at Wheelock Avenue which will change from level of service rating "B" to "C" in the A.M. peak generator hour.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-10 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 1996 "No Build" and "Build" conditions.

As shown in the table, all of the analyzed intersection movements in the "No Build" condition are operating at acceptable level of service ratings.

As shown in the table, all of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings. The traffic turning left or right from westbound Route 20 to Grafton St. in the P.M. peak hour will be at LOS "E".

Table 1.4-9 1996 Peak Generator Hour Signalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	A(4.2)	B(7.5)	A(4.2)	B(6.9)
Eastbound	A(2.2)	B(6.9)	A(2.2)	B(6.9)
Westbound	A(3.4)	B(7.1)	A(3.4)	B(7.1)
Northbound	B(9.9)	B(8.4)	A(9.9)	B(6.6)
Route 122 and Wheelock**	A(2.8)	A(2.2)	A(3.4)	A(2.2)
Eastbound	A(2.0)	A(1.3)	A(1.3)	A(1.3)
Westbound	A(2.0)	A(1.7)	A(1.4)	A(1.6)
Northbound	B(9.0)	C(15.1)	C(20.6)	C(15.1)
Route 20 and Mall**	-	-	B(7.1)	B(10.7)
Eastbound	-	-	B(5.5)	B(6.2)
Westbound	-	-	B(10.0)	B(10.6)
Northbound	-	-	D(26.1)	D(36.2)
Southbound	-	-	B(15.0)	C(16.8)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Table 1.4-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(395)	A(427)	B(395)	A(454)
LT and RT from Ramp	D(149)	D(124)	D(139)	E(82)
SB Grafton and Route 20 East				
RT from Ramp	C(291)	B(384)	B(325)	B(379)
NB Grafton and Route 20 East				
RT from Ramp	B(370)	B(342)	B(369)	B(361)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(565)	B(370)	A(566)	B(373)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(480)	A(654)	A(465)	A(652)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	A(422)	A(581)	B(397)	A(585)
Route 20 and Mall				
LT from EB Route 20	A(480)	B(301)	-	-
LT from WB Route 20	C(297)	A(533)	-	-
All from Truck Business	D(105)	D(103)	-	-
RT from Mall	A(678)	A(452)	-	-

LOS (Reserve Capacity - Vehicles)

Traffic turning from WB Route 20 to Grafton Street has a reduction in level of service, from LOS "D" to LOS "E", in the P.M. generator hour. Also, right turning traffic from NB Grafton Street to EB Route 20 experiences a reduction in level of service rating from "A" to "B" in the A.M. peak generator hour.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.4-11 lists the results of the analysis of the A.M. and P.M. peak generator hours.

As shown in the table, half of the analyzed roadway segments are operating in the "No Build" condition at the peak hour level of service rating of "E". However, only one segment operates with an unacceptable reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton St. in the A.M. Peak Generator Hour.

As shown in the table, half of the analyzed roadway segments are operating in the "Build" condition at the peak generator hour level of service rating of "E". However, only one segment operates with an unacceptable reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton St. in the A.M. Peak Generator Hour.

No peak generator hour level of service rating drops will result in the roadway segments from the traffic entering or exiting the commuter rail station with the exception of EB Route 20 west of the Mall which experiences a reduction in level of service rating from "A" to "B" in the A.M. peak generator hour.

Table 1.4-11 1996 Peak Generator Hour Road Segment Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	D(1040)	D(1350)	D(1041)	D(1350)
Route 122 North of Exit 11	E(811)	E(892)	E(899)	E(965)
Route 122 North of Wheelock	E(868)	E(854)	E(873)	E(925)
Route 20 West of Route 122	E(553)	E(853)	E(529)	E(813)
EB Route 20 West of Mall	A(2165)	A(2449)	B(2079)	A(2441)
WB Route 20 West of Mall	A(2552)	A(2365)	A(2541)	A(2299)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis

The Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.4-12 lists the site generated traffic as a percentage of the total traffic at the various intersections and road segments analyzed within the study area during the 1996 A.M. and P.M. peak hours.

As shown in the Table none of the intersections or road segments analyzed exceed the 10 percent requirement.

Table 1.4-12 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Route 122 and Exit 11	0.0%	0.0%
Route 122 and Wheelock	0.3%	0.0%
Route 122 NB and EB 20 Ramp	0.3%	0.0%
Route 122 SB and EB 20 Ramp	0.4%	0.0%
Route 122 and WB Route 20 Ramp	0.5%	0.1%
Route 20 EB and SB 122 Ramp	3.7%	0.1%
Route 20 EB and NB 122 Ramp	4.0%	0.1%
Route 20 WB and Route 122 Ramp	0.6%	0.9%
Route 20 and Mall and Driveway	3.5%	0.8%
Roadway Segment		
Route 122 South of Exit 11	0.0%	0.0%
Route 122 North of Exit 11	0.0%	0.0%
Route 122 North of Wheelock	0.3%	0.0%
Route 20 West of Route 122	2.4%	0.7%
Route 20 West of Mall	3.2%	0.8%

Site generated traffic as a percentage of total traffic

Year 1996 Millbury Station Only

In order to address an upper limit, worst case situation with regard to traffic impacts on Millbury Streets, an analysis was performed which considered that the Millbury commuter station was the only commuter station built by 1996 (in addition to a Worcester Station).

The 1996 "No Build" traffic volumes, for both the peak hours and peak generator hours, were previously presented and serve as the same base for the "Millbury Station Only" as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Millbury Station Only)

In support of this study the Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership for the Millbury Station, employing an unconstrained parking supply. In 1996, the Millbury Station is projected to attract 347 daily round trip commuters, 319 of which would be Park'n'Ride patrons. These patrons are expected to reside in the Towns of Millbury, Shrewsbury, Grafton, Sutton, Boylston, Northbridge, Oxford, Charlton, Auburn, and the City of Worcester. The number of patrons who originate from each community are shown in Table 1.4-13. The Ridership has been adjusted to reflect peak period usage which is 94% of the total daily demand.

Table 1.4-13 Projected Patrons of Millbury Station Only Year 1996

City/Town	Riders*
Millbury	28
Grafton	35
Shrewsbury	77
Sutton	15
Boylston	16
Northbridge	26
Oxford	18
Charlton	20
Auburn	27
Worcester	64
TOTAL	**326**

* *Adjusted for peak period demand*

Year 1996 Trip Distribution and Assignment (Millbury Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.4-14 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.4-14 MBTA Ridership Distribution (Millbury Station Only)

Inbound Train	Patrons
502A	64
504A	106
506A	105
510	51
TOTAL	**326**
Outbound Train	**Patrons**
515A	46
519	76
521	75
521A	113
523	16
TOTAL	**326**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Millbury Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute

waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Millbury the typical A.M. and P.M. roadway peak hours are from 7:15 to 8:15 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 6:00 to 7:00 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Millbury would utilize eastbound Route 20 or northbound Wheelock Avenue, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station. Actual routing was based on shortest travel time and distance from population centers. Figure 1.4-15 shows the percentage of station related traffic utilizing the study area roadways.

Year 1996 "Build" Traffic Volumes (Millbury Station Only)

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

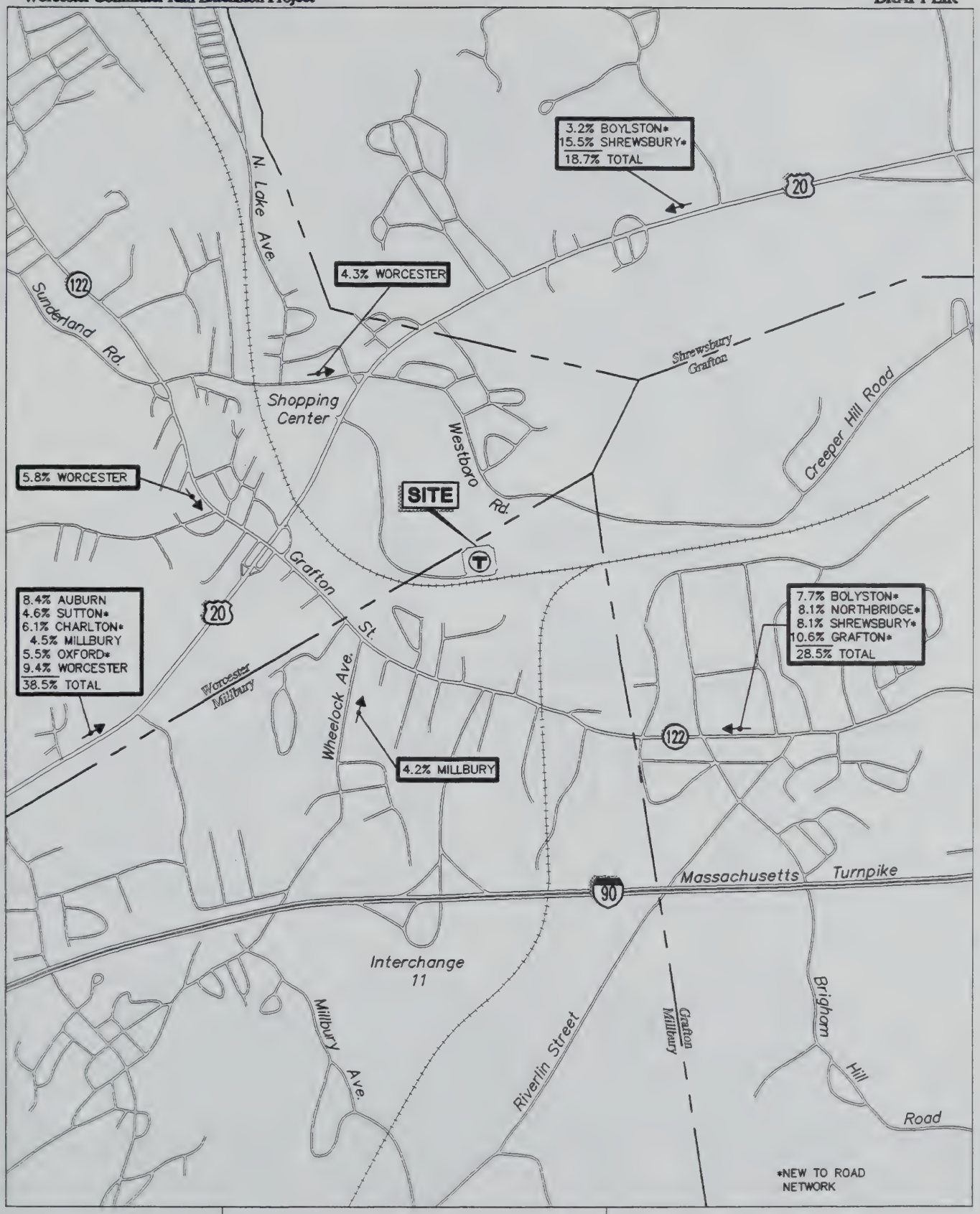
- the projected year 1996 "No Build" traffic volumes.
- traffic specifically diverted to the proposed Millbury Station.

A portion of the traffic volumes heading to the proposed station would be diverted from the existing travel route to the Mass Pike, (travel route being Grafton Street, Route 122). These existing vehicle trips would not be generated as new trips. The vehicles currently by-passing the site were not assigned to the roadway network as new trips, they are only shown as being diverted from the Mass Pike to the commuter rail site.

Figure 1.4-16 shows the projected A.M. peak hours traffic volumes. Figure 1.4-17 shows the projected P.M. peak hour traffic volumes. Figure 1.4-18 shows the projected A.M. peak generator hour traffic volumes. Figure 1.4-19 shows the projected P.M. peak generator hour traffic volumes.

Year 1996 Peak Hour Level of Service (Millbury Station Only)

The same study area elements that were analyzed under the 1992 Existing Conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing

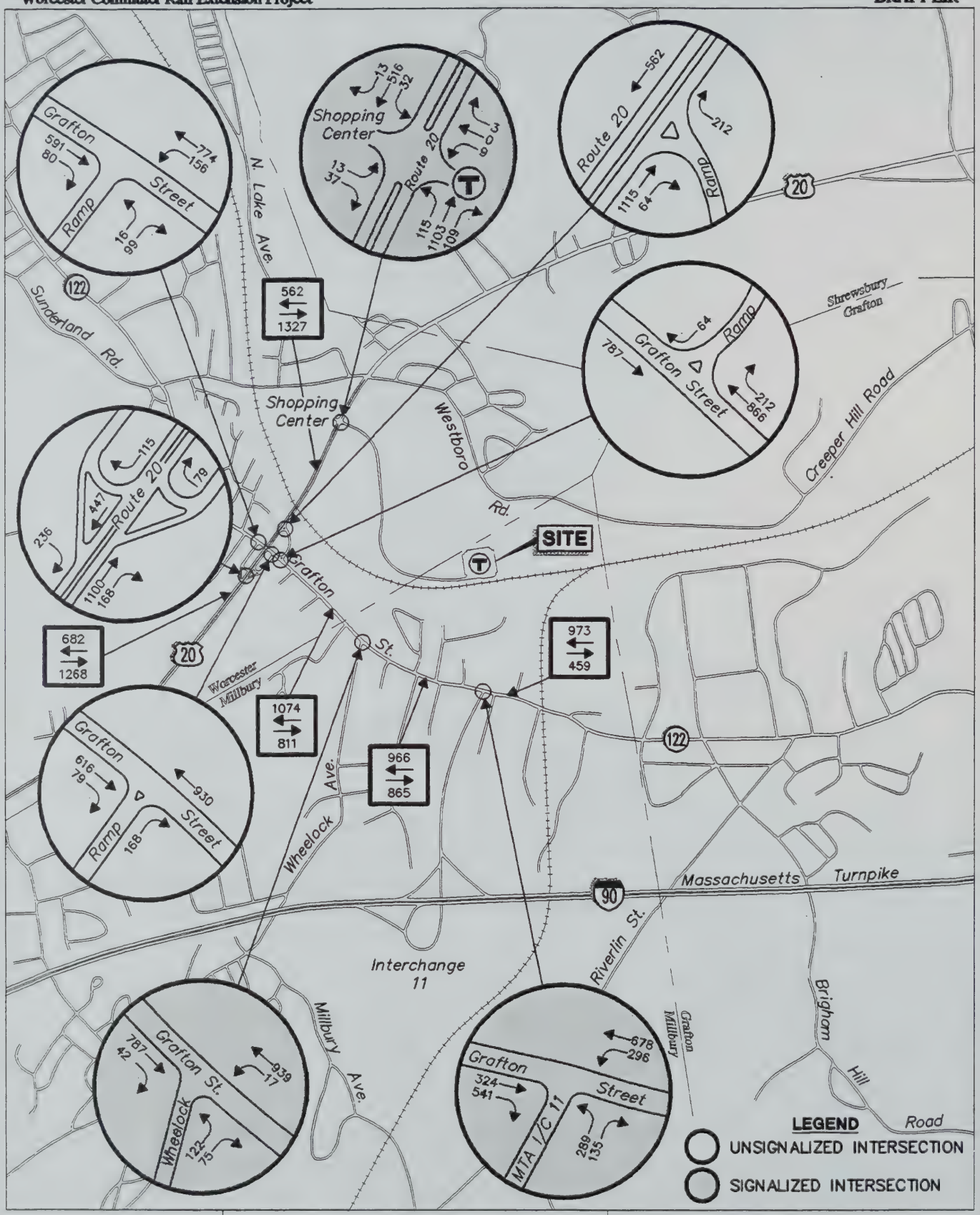


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

Distribution of Traffic
1996 BUILD Millbury Only
Millbury Station - Route 20

FIGURE 1.4-15



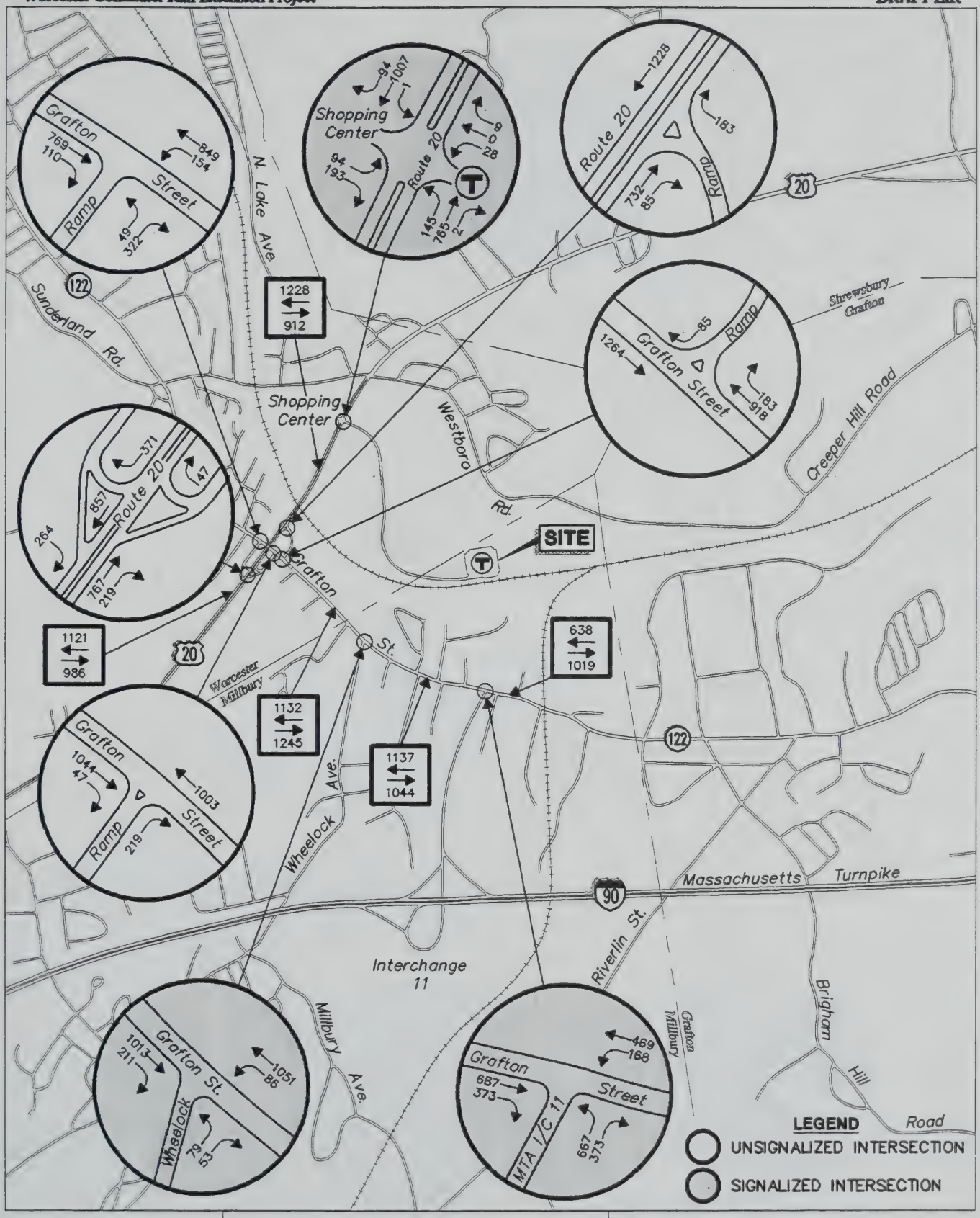
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:15 - 8:15 A.M.
1996 BUILD Millbury Only
Millbury Station - Route 20

FIGURE 1.4-16

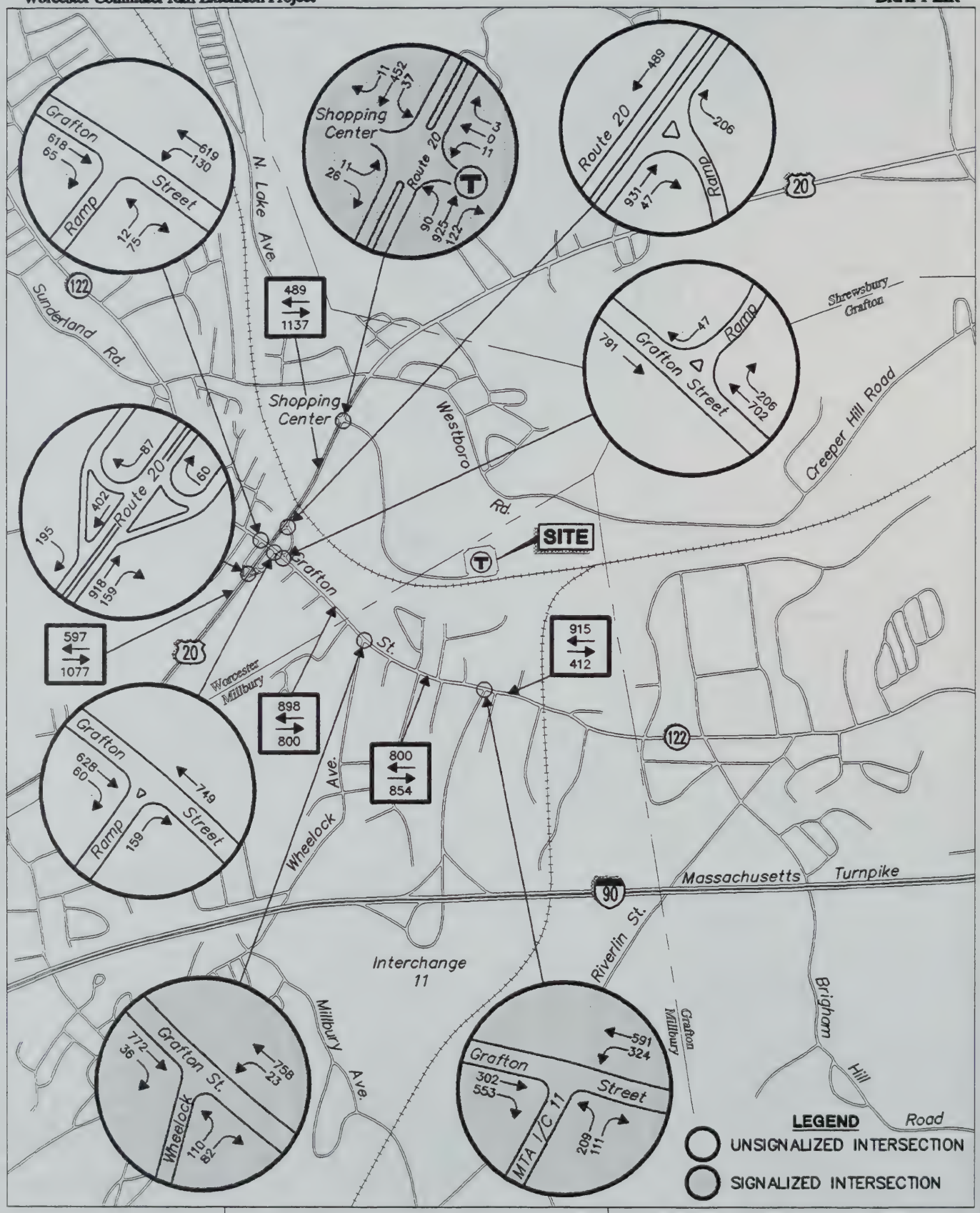


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD Millbury Only
Millbury Station - Route 20

FIGURE 1.4-17

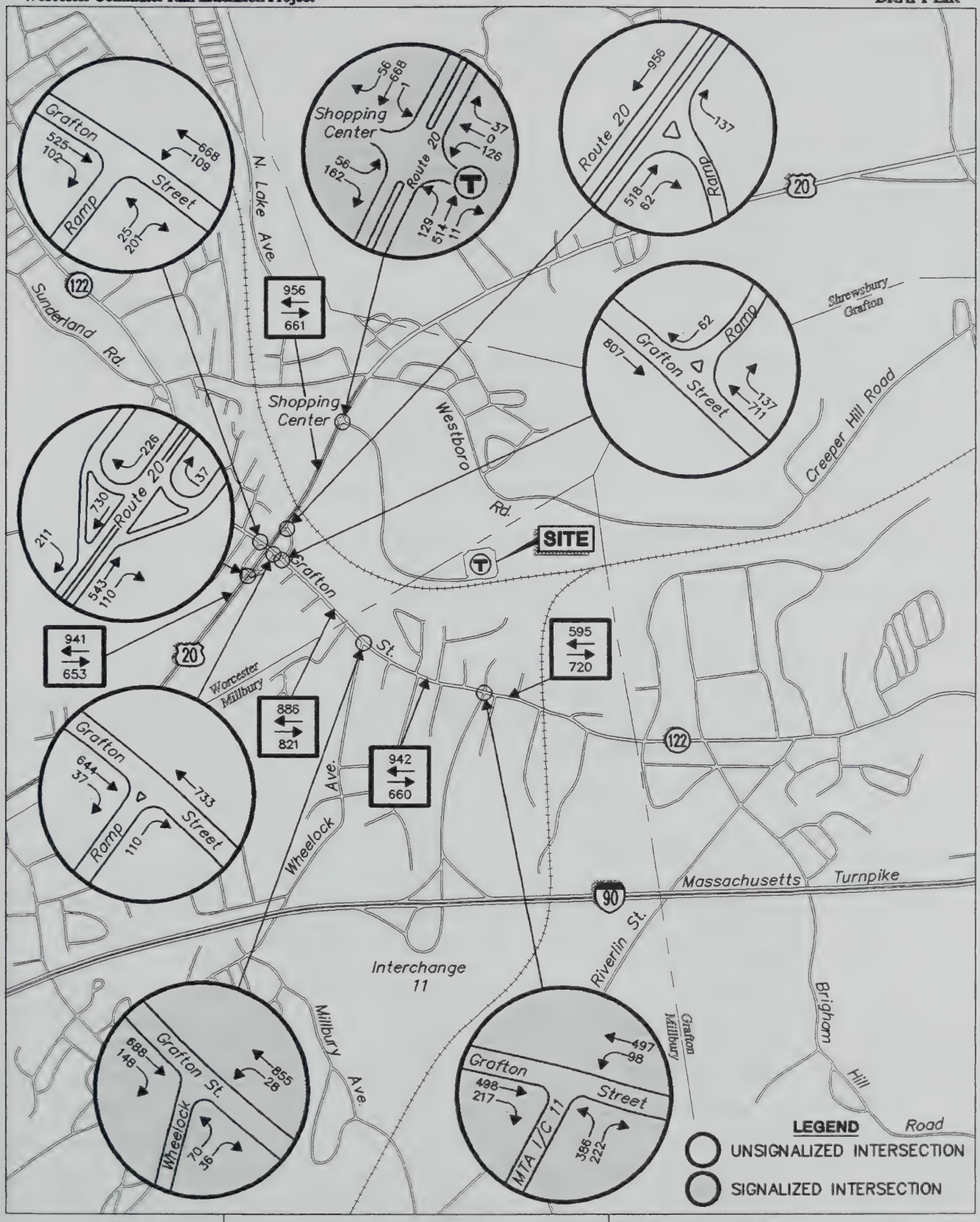


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 BUILD Millbury Only
Millbury Station - Route 20

FIGURE 1.4-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
1996 BUILD Millbury Only
Millbury Station - Route 20

FIGURE 1.4-19

conditions. Roadway geometrics, etc. remain unchanged. As in the 1996 "Build All Stations" scenario, it is assumed that the Route 20/Mall intersection will be signalized in the "Build" condition.

Signalized Intersection

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-15 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

Under the 1996 "No Build" condition both existing intersections will operate at overall acceptable level of service ratings. The northbound movement at Exit 11 will operate at level of service rating "E" in the P.M. peak hour.

Under the 1996 "Build" condition all three signalized intersections are expected to operate at overall acceptable level of service ratings. The northbound movement at Exit 11 will continue to function at level of service rating "E" in the P.M. peak hour. No change in peak hour levels of service are anticipated due to traffic entering or existing the commuter rail station.

Table 1.4-15 1996 Peak Hour Signalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(5.4)	D(34.6)	B(5.7)	D(33.6)
Eastbound	A(2.6)	C(15.1)	A(2.6)	C(15.4)
Westbound	A(4.4)	D(26.7)	A(4.9)	D(31.4)
Northbound	B(11.2)	E(59.6)	B(11.3)	E(52.9)
Route 122 and Wheelock**	A(2.6)	B(6.0)	A(2.8)	B(5.5)
Eastbound	A(2.0)	A(1.4)	A(1.9)	A(1.5)
Westbound	A(2.1)	B(6.3)	A(2.2)	B(6.2)
Northbound	B(10.2)	D(34.5)	B(9.5)	D(28.7)
Route 20 and Mall	-	-	B(8.3)	C(15.4)
Eastbound	-	-	B(6.3)	B(10.8)
Westbound	-	-	B(11.1)	B(13.5)
Northbound	-	-	D(25.9)	C(24.5)
Southbound	-	-	D(25.8)	D(36.7)

LOS (Average Vehicle Stopped Delay in Seconds)

** *Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-16 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak traffic hours under the 1996 "No Build" and "Build" conditions.

As shown in the table, most of the analyzed intersection movements in the "No Build" condition operate at acceptable level of service ratings. Traffic turning left or right from westbound Route 20 to Grafton Street will operate at LOS "E" in the A.M. peak hour, while traffic turning right from eastbound Route 20 will operate at LOS "E" in the P.M. peak hour.

The following movements operate at unacceptable LOS "F":

- Left and right turning traffic from WB Route 20 to Grafton Street in the P.M. peak hour.
- All NB traffic movements from the truck business at Route 20 in the P.M. peak hour.

As shown in the table most of the analyzed intersection movements in the "Build" condition operate at acceptable level of service ratings. Traffic turning left or right from westbound Route 20 to Grafton Street is at LOS "E" in the A.M. pear hour, while traffic turning right from eastbound Route 20 is at LOS "E" in the P.M. peak hour. Only left and right turning traffic from WB Route 20 to Grafton Street in the P.M. peak hour will operate at LOS "F".

No reductions in level of service occur as the result of traffic entering or exiting the commuter rail station except for right turning traffic from NB Grafton Street to EB Route 20. The level of service rating for this movement changes from "B" to "C" in the A.M. peak hour.

Table 1.4-16 1996 Peak Hour Unsignalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(371)	C(250)	B(376)	C(257)
LT and RT from Ramp	E(66)	F(-253)	E(62)	F(-265)
SB Grafton and Route 20 East				
RT from Ramp	C(287)	E(68)	B(320)	E(62)
NB Grafton and Route 20 East				
RT from Ramp	C(270)	C(218)	C(259)	C(222)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(488)	C(204)	A(487)	C(203)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	B(393)	A(507)	B(377)	A(507)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(334)	A(433)	C(267)	A(434)
Route 20 and Mall				
LT from EB Route 20	A(413)	D(121)	-	-
LT from WB Route 20	C(227)	B(380)	-	-
All from Truck Business	A(448)	F(-4)	-	-
RT from Mall	A(641)	C(289)	-	-

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.4-17 lists the results of the analysis for the A.M. and P.M. peak hours.

As shown in the table most of the analyzed road segments are operating in the "No Build" condition at the peak hour level of service rating of "E". Of the road segments operating at level of service rating "E" the following have an unacceptable reserve capacity:

- Route 122 North of Exit 11 in the P.M. peak hour.
- Route 122 North of Wheelock in the P.M. peak hour.
- Route 20 West of Grafton Street in the A.M. and P.M. peak hours.

As shown in the table most of the analyzed road segments are operating in the "Build" condition at the peak hour level of service rating of "E". Of the road segments operating at level of service rating "E" the following have an unacceptable reserve capacity:

- Route 122 North of Exit 11 in the P.M. peak hour.
- Route 122 North of Wheelock in the P.M. peak hour.
- Route 20 West of Grafton Street in the A.M. and P.M. peak hours.

Table 1.4-17 1996 Peak Hour Road Segment Level of Service (Millbury Station Only)

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(949)	E(810)	E(877)	E(798)
Route 122 North of Exit 11	E(706)	E(396)	E(667)	E(414)
Route 122 North of Wheelock	E(610)	E(213)	E(547)	E(210)
Route 20 West of Route 122	E(307)	E(449)	E(277)	E(449)
EB Route 20 West of Mall	B(1995)	A(2353)	B(1910)	A(2345)
WB Route 20 West of Mall	A(2383)	B(2139)	A(2396)	B(2091)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Peak Generator Hour Level of Service (Millbury Station Only)

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.4-18 for the 1996 "No Build" and "Build" conditions.

As shown in the table both intersections will operate at an acceptable level of service under the "No Build" conditions. None of the individual movements analyzed will experience excessive delay.

All three signalized intersections will continue to operate at acceptable levels of service under the "Build" condition. None of the individual movements analyzed will experience excessive delay.

No reduction in peak generator hour level of service ratings are expected due to the traffic entering or existing the proposed commuter rail station.

Table 1.4-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	A(4.2)	B(7.5)	A(4.4)	B(7.3)
Eastbound	A(2.2)	B(6.9)	A(2.2)	B(8.2)
Westbound	A(3.4)	B(7.1)	A(3.8)	B(7.2)
Northbound	B(9.9)	B(8.4)	B(9.9)	B(6.5)
Route 122 and Wheelock**	A(2.8)	A(2.2)	A(3.4)	A(2.2)
Eastbound	A(2.0)	A(1.3)	A(2.1)	A(1.4)
Westbound	A(2.0)	A(1.7)	A(2.3)	A(1.6)
Northbound	B(9.0)	C(15.1)	B(13.7)	C(15.1)
Route 20 and Mall**	-	-	B(7.9)	C(15.2)
Eastbound	-	-	B(5.7)	B(12.5)
Westbound	-	-	B(11.2)	B(13.4)
Northbound	-	-	D(26.0)	D(25.3)
Southbound	-	-	C(24.6)	C(22.4)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed for the A.M. and P.M. peak generator hours for both the "No Build" and "Build" conditions. The results of the analysis are listed in Table 1.4-19.

Under the "No Build" condition all intersection movements will operates at acceptable level of service ratings. No movements are expected to experience excessive delay.

Under the "Build" condition, all intersection movements will operate at acceptable level of service ratings. Left and right turning traffic from WB Route 20 to Grafton Street in the P.M. peak generator hour will operate at LOS "E".

No reduction in peak generator hour level of service ratings are anticipated due to traffic entering or exiting the proposed commuter rail station except for left and right turning traffic from WB Route 20 to Grafton Street. This movement will see a reduction in level of service rating from "D" to "E" in the P.M. peak generator hour.

Table 1.4-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Millbury Station Only)

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(395)	A(427)	B(395)	A(456)
LT and RT from Ramp	D(149)	D(124)	D(140)	E(60)
SB Grafton and Route 20 East				
RT from Ramp	C(291)	B(384)	B(328)	B(383)
NB Grafton and Route 20 East				
RT from Ramp	B(370)	B(342)	B(355)	B(364)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(565)	B(370)	A(563)	B(351)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(480)	A(654)	A(460)	A(651)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	A(422)	A(581)	B(343)	A(580)
Route 20 and Mall				
LT from EB Route 20	A(480)	B(301)	-	-
LT from WB Route 20	C(297)	A(533)	-	-
All from Truck Business	D(105)	D(103)	-	-
RT from Mall	A(678)	A(452)	-	-

Roadway Segments

The roadway segments were analyzed for the A.M. and P.M. peak generator hours for the "No Build" and "Build" conditions. The results of the analysis are listed in Table 1.4-20.

Under the "No Build" condition several segments operate at a level of service rating of "E". However, only Route 20 west of Route 122 during the A.M. peak generator hour has an unacceptable reserve capacity.

Under the "Build" condition most segments continue to operate at a level of service of "E". Route 20 west of Route 122 during the A.M. peak generator hour continues to have an unacceptable reserve capacity. Route 122 south of Exit 11 experiences a decline in level of service from "D" to "E" during the A.M. peak generator hour. Likewise, EB Route 20 west of the Mall experiences a decline in level of service from "A" to "B" during the A.M. peak generator hour.

Table 1.4-20 1996 Peak Generator Hour Segment Level of Service (Millbury Station Only)

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	D(1040)	D(1350)	E(975)	D(1264)
Route 122 North of Exit 11	E(811)	E(892)	E(869)	E(886)
Route 122 North of Wheelock	E(868)	E(854)	E(807)	E(889)
Route 20 West of Route 122	E(553)	E(853)	E(518)	E(798)
EB Route 20 West of Mall	A(2165)	A(2449)	A(2021)	A(2487)
WB Route 20 West of Mall	A(2552)	A(2365)	A(2387)	A(2231)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis

The Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.4-21 lists the site generated traffic as a percentage of the total traffic at the various intersections and road segments analyzed within the study area during the 1996 A.M. and P.M. peak hours.

As shown in the table, none of the intersections or road segments analyzed exceed the 10 percent requirement.

Table 1.4-21 1996 "Build" Condition - 10% Analysis (Millbury Station Only)

Intersection	Peak Hours	
	A.M.	P.M.
Route 122 and Exit 11	1.9%	0.4%
Route 122 and Wheelock	2.6%	0.6%
Route 122 NB and EB 20 Ramp	2.6%	0.6%
Route 122 SB and EB 20 Ramp	0.7%	0.6%
Route 122 and WB Route 20 Ramp	0.8%	0.7%
Route 20 EB and SB 122 Ramp	4.7%	0.1%
Route 20 EB and NB 122 Ramp	7.8%	0.2%
Route 20 WB and Route 122 Ramp	1.1%	1.9%
Route 20 and Mall and Driveway	7.8%	1.7%
Roadway Segment		
Route 122 South of Exit 11	3.0%	0.7%
Route 122 North of Exit 11	2.3%	0.6%
Route 122 North of Wheelock	2.7%	0.6%
Route 20 West of Route 122	3.0%	0.7%
Route 20 West of Mall	6.2%	1.4%

Site generated traffic as a percentage of total traffic

Year 2001 Conditions

To determine the impacts directly attributable to the proposed rail station, the year 2001 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

As noted in the year 1996 conditions, it is proposed to signalize the intersection of Route 20 and the Mall driveway. Therefore, this intersection was analyzed as a signalized intersection in the "Build" condition.

Year 2001 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments within the study area.
- Increases in existing traffic volumes due to population growth and development within the vicinity of, but outside of the study area.

Through discussions with the Town of Millbury, it was determined that no major new developments are planned within the study area by 2001. Therefore, this element does not affect the estimation of the 2001 "No Build" traffic volumes.

Current economic projections are for positive growth of 1.4% in 1996 and for 1.6% in 1997. If these projections are correct the growth in the background traffic volumes should also start increasing to a more normal rate of around 1.5% per year.

To account for the expected return to normal economic times the 1996 "No Build" traffic volumes were increased by 1.5% per year to obtain the year 2001 "No Build" traffic volumes.

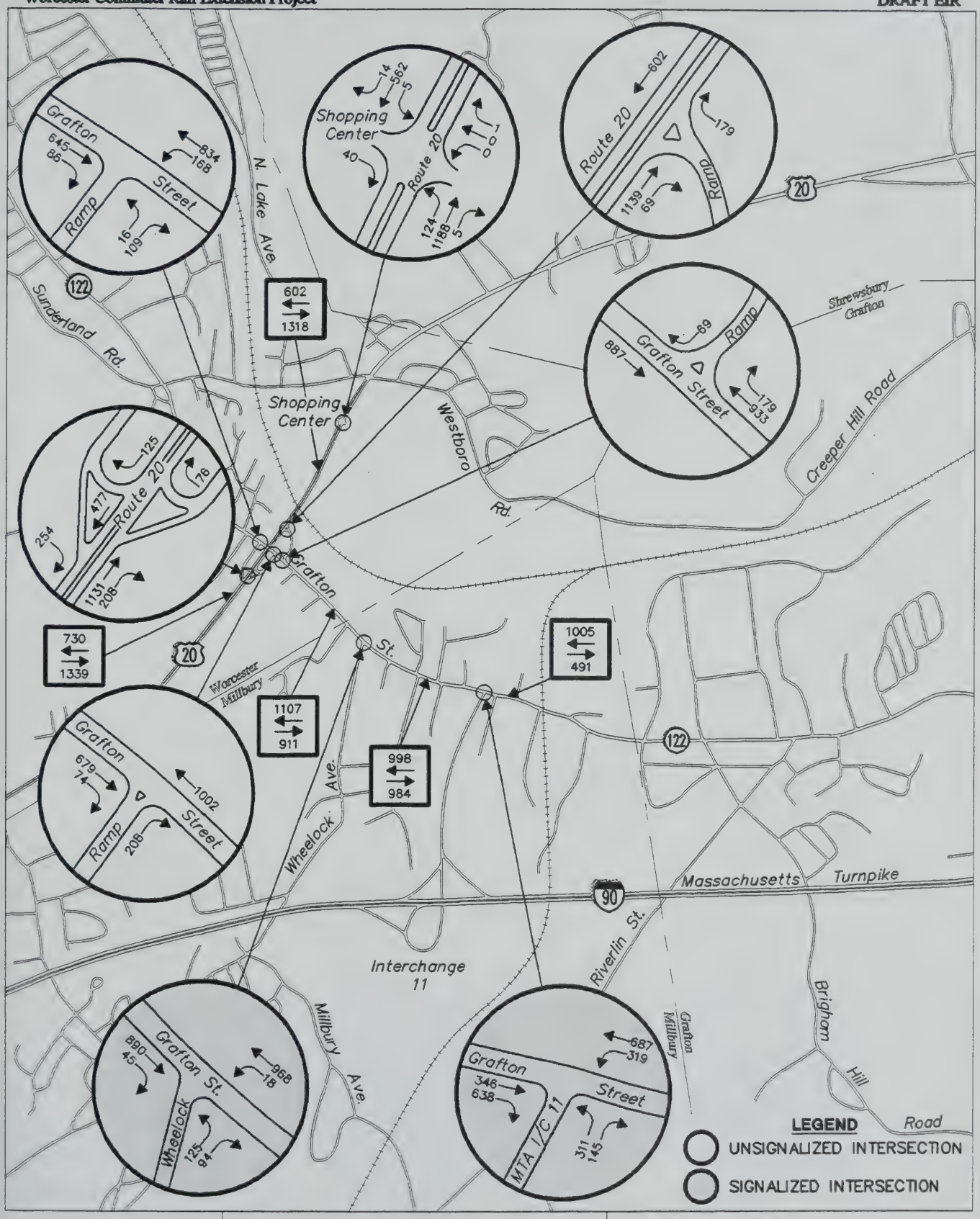
Figure 1.4-20 shows the projected A.M. peak hour traffic volumes. Figure 1.4-21 shows the projected P.M. peak hour traffic volumes. Figure 1.4-22 shows the projected A.M. peak generator hour traffic volumes. Figure 1.4-23 shows the projected P.M. peak generator hour traffic volumes.

The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to Worcester.

Year 2001 Trip Generation and Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 commuters are expected to utilize the railroad for daily round trip commuting into Boston.

In 2001, the proposed Millbury Station is projected to attract a total of 162 daily round trip commuters. Thirteen of these patrons would be dropped off at the station. Based upon an average automobile occupancy rate of 1.12, the remaining 149 patrons would result in a parking demand of 133 parking spaces. This leaves 167 parking spaces empty in the year 2001.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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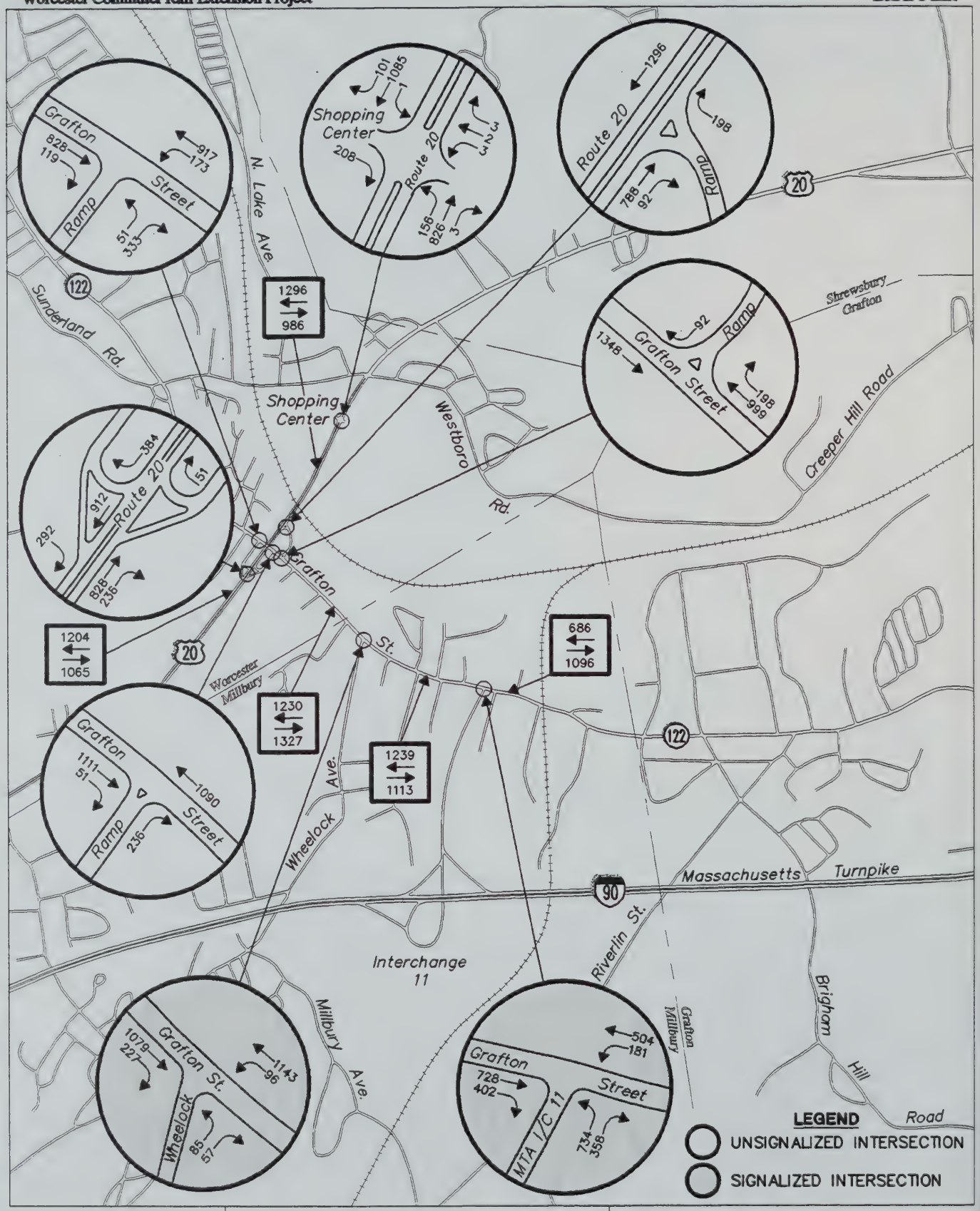
A.M. Peak Hour
7:15 - 8:15 A.M.
2001 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-20

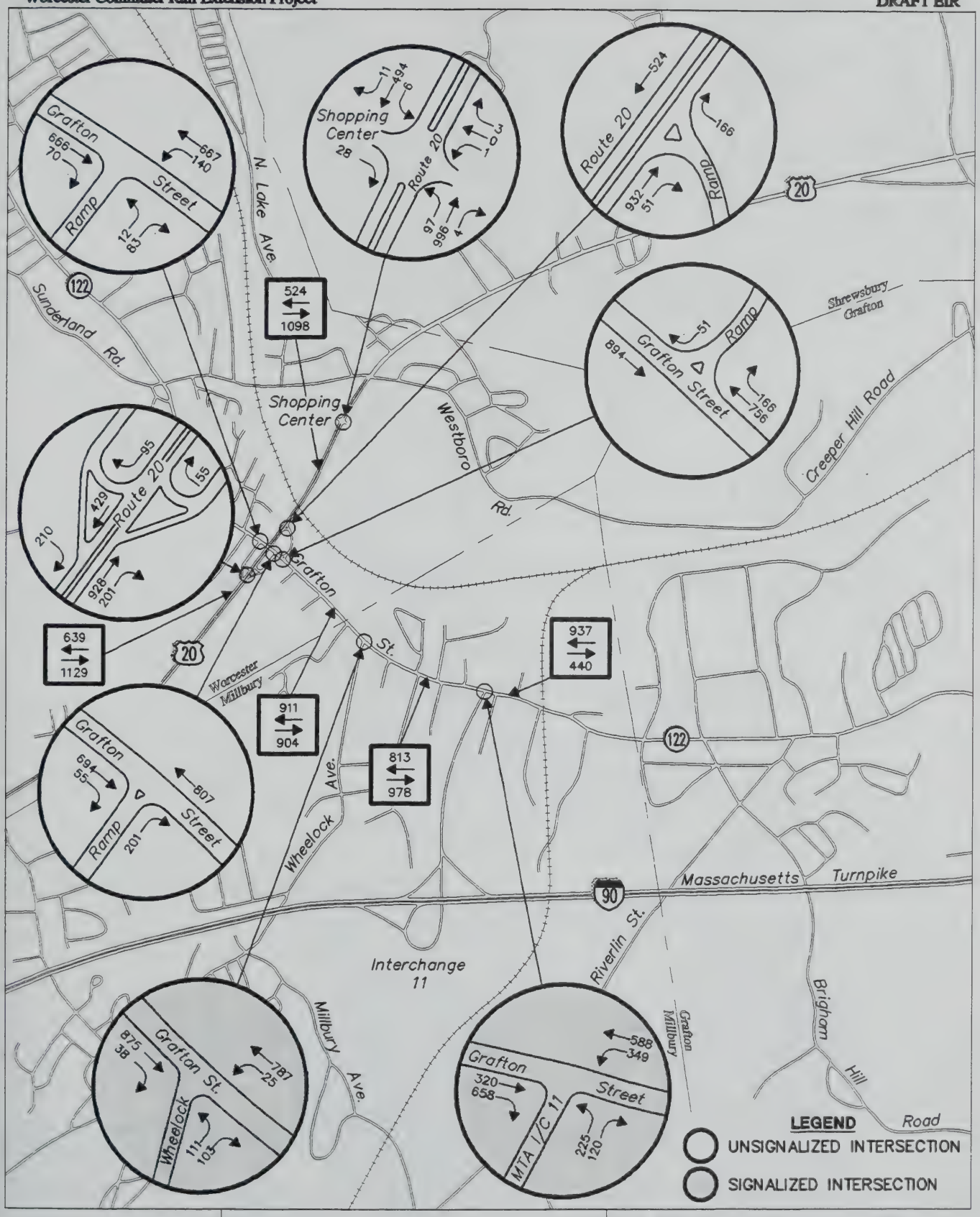


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Hour
5:00 - 6:00 P.M.
2001 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-21



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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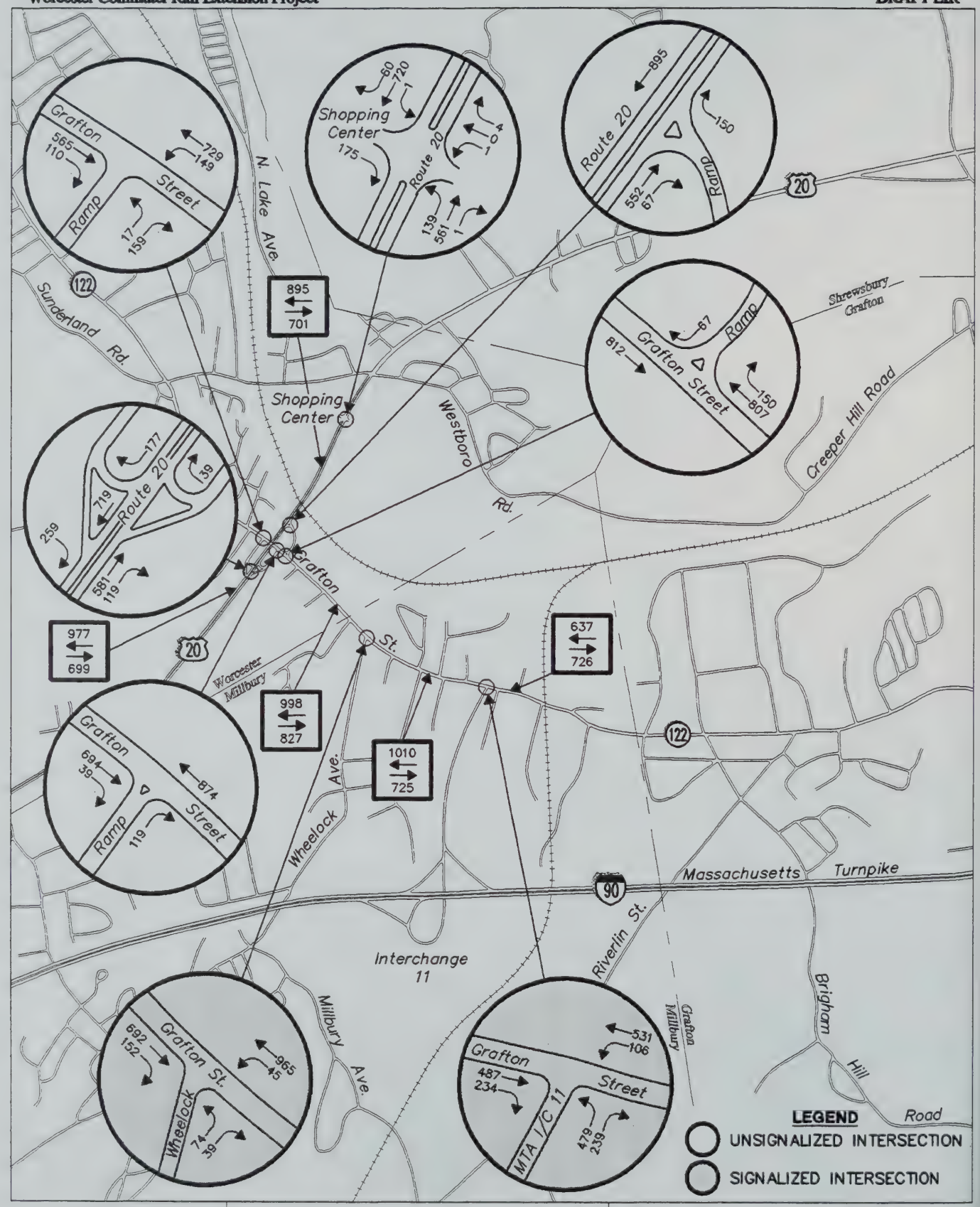
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
2001 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-22



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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P.M. Peak Generator Hour
6:00 - 7:00 P.M.
2001 NO BUILD
Millbury Station - Route 20

FIGURE 1.4-23

These patrons are expected to reside in the Towns of Auburn, Charlton, Millbury, Oxford, and the City of Worcester. The number of patrons who originate from each town are shown in Table 1.4-22. The ridership has been adjusted to reflect peak period usage, which is 94% of total daily demand.

Table 1.4-22 Projected Patrons of Millbury Station - Year 2001

Town	Riders*
Auburn	31
Charlton	17
Millbury	25
Oxford	18
Worcester	61
TOTAL	152

* *Adjusted for peak period demand*

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day (7:30, 8:00, 8:30, or 9:00) will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business (4:30, 5:00, 5:30, or 6:00 P.M.) are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on current ridership per train and the arrival or departure times in Boston of said trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.4-23 lists the projected distribution of ridership from the Millbury Station based on the expected arrival in Boston or departure time from Boston.

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the out of pocket cost savings in parking and tolls. The commuters who shift to

commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time typically results in the A.M. and P.M. peak hours for the site to lie totally or partially out side of the typical peak hour ranges of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M. thus there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Millbury Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Millbury the typical A.M. and P.M. intersection peak hours are from 7:15 to 8:15 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 6:00 to 7:00 P.M.

Once the project generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Millbury would utilize eastbound Route 20 or northbound Wheelock Avenue, depending on the location of their residences. Riders originating in towns outside that which the station is located were assigned to the major roads from their town to the station.

Table 1.4-23 MBTA Ridership Distribution

Inbound Train	Patrons
502A	30
504A	49
506A	49
510	24
TOTAL	**152**
Outbound Train	**Patrons**
515A	21
519	35
521	35
521A	53
523	8
TOTAL	**152**

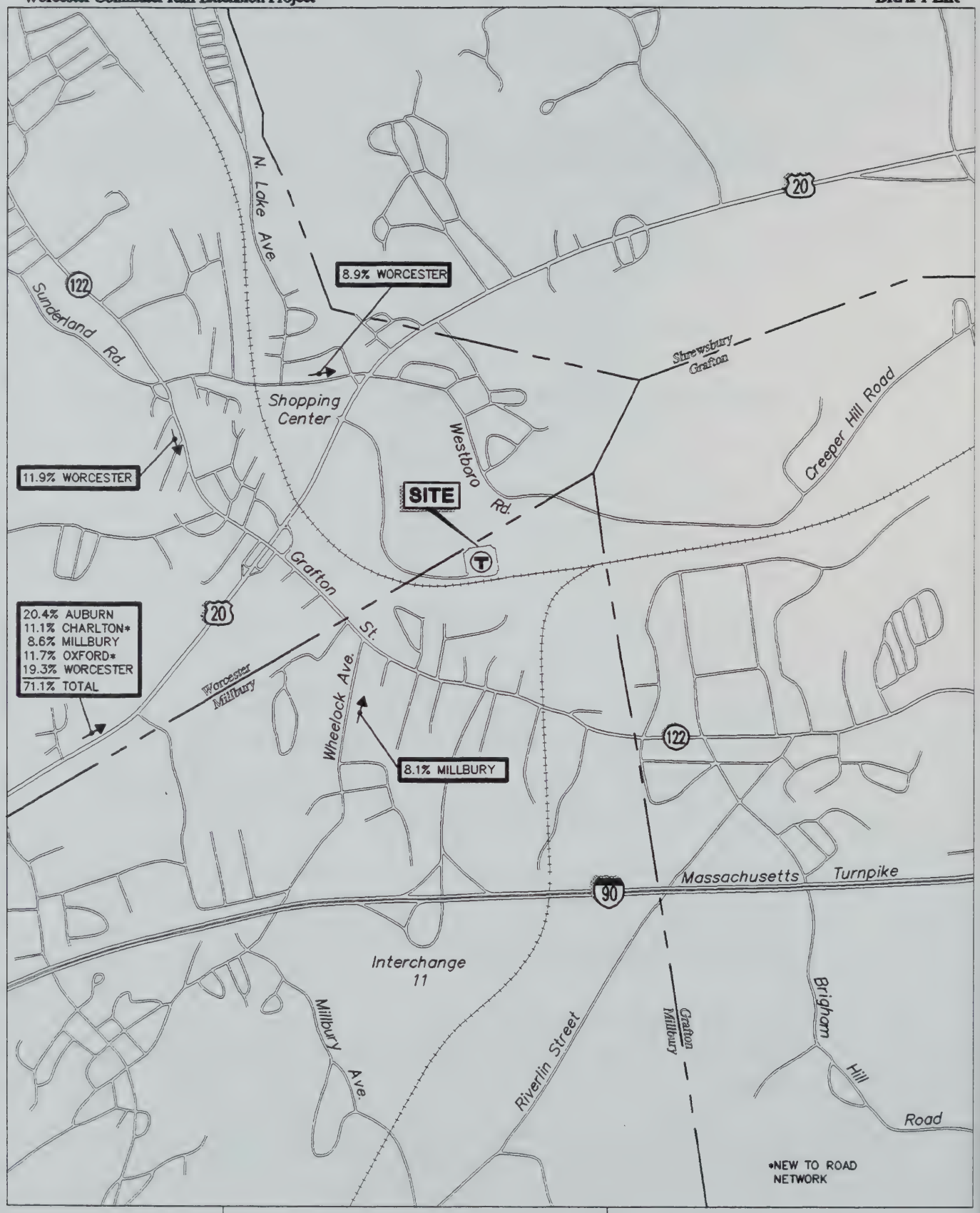
The patrons from Auburn, Charlton, and Oxford would access the station from eastbound U.S. Route 20. The patrons from Worcester would access the station from eastbound Route 20, westbound Route 20, or southbound Route 122. Actual routing was estimated based on the shortest travel time and distance from population centers. Figure 1.4-24 shows the percentage of station related traffic utilizing the study area roadways for the year 2001 "Build" condition.

Approximately the same number of vehicle trips will be made in the study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along Route 122 and the Mass Pike. Traffic volumes are expected to increase on Route 20 west of Route 122.

Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

- The projected year 2001 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Millbury rail station.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

Distribution of Traffic
2001 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-24

A portion of the traffic volumes heading to the proposed station would be diverted from the existing travel route to the Mass Pike (the travel route being Grafton Street, Route 122). These existing vehicle trips would not be generated as new trips. The vehicles currently by-passing the site were not assigned to the roadway network as new trips, they are only shown as being diverted from the Mass Pike to the commuter rail site.

Figure 1.4-25 shows the projected A.M. peak hour traffic volumes. Figure 1.4-26 shows the projected P.M. peak hour traffic volumes. Figure 1.4-27 shows the projected A.M. peak generator hour traffic volumes. Figure 1.4-28 shows the projected P.M. peak generator hour traffic volumes.

Year 2001 Peak Hour Level of Service

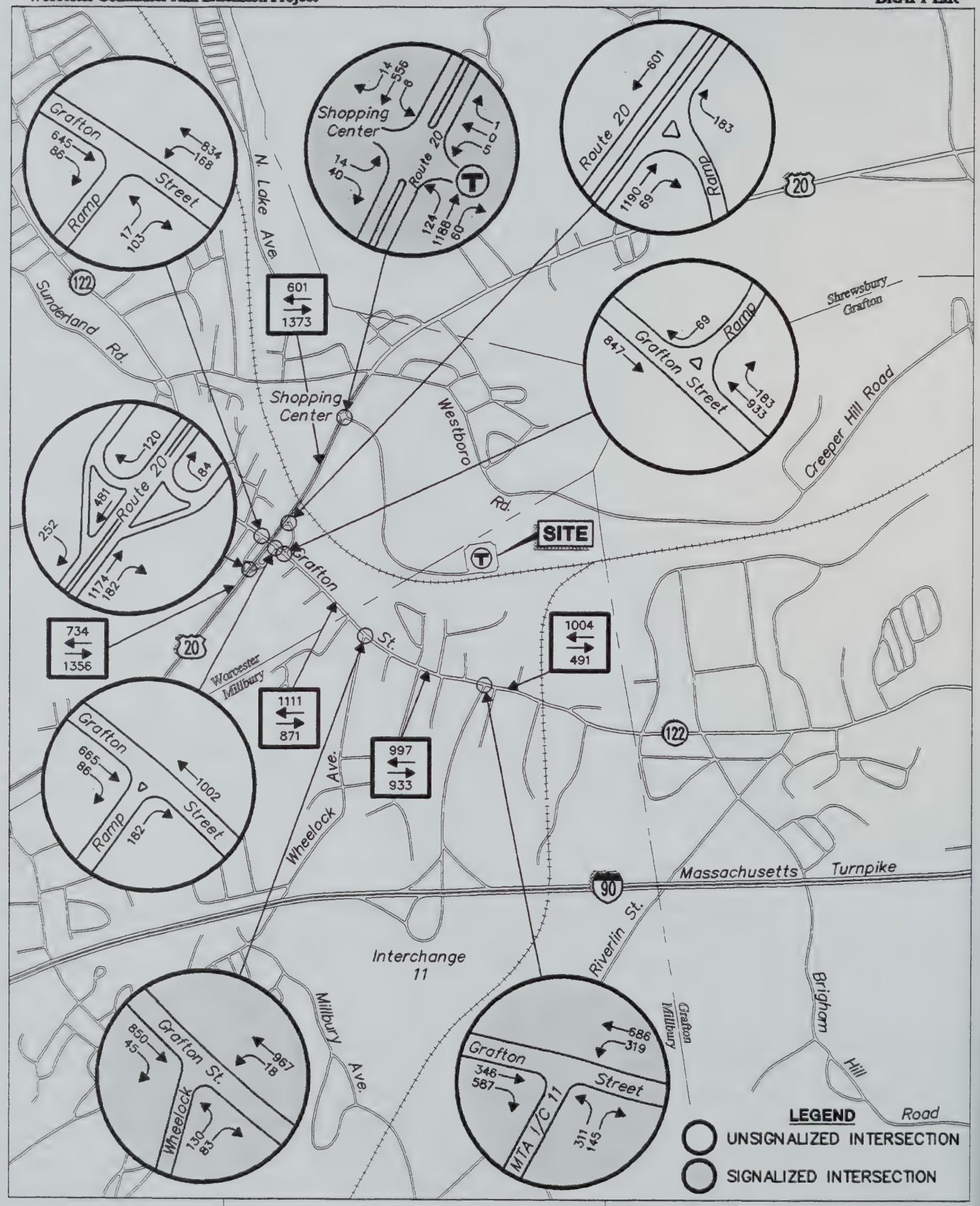
The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only major parameter in the analysis to change from the existing conditions. Roadway geometries, signal phasing, percentages of heavy vehicles, etc. remain unchanged. As previously noted, the Route 20/Mall intersection was analyzed as a signalized intersection in the "Build" condition.

The traffic signal timings for the 2001 "No Build" condition and for the 2001 "Build" condition were optimized. Normal maintenance of traffic signals includes the recounting of intersection traffic volumes and the retiming of the traffic signals to account for changes in traffic volumes and travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-24 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours under the 2001 "No Build" and "Build" conditions.

Under the 2001 "No Build" conditions the intersection of Route 122 with Wheelock will operate at overall acceptable level of service ratings. The northbound approach will operate at LOS "E" in the P.M. peak hour. The intersection of Route 122 with Exit 11 will be at LOS "F" in the P.M. peak with both the northbound movement and the westbound also movement operating at LOS "F".



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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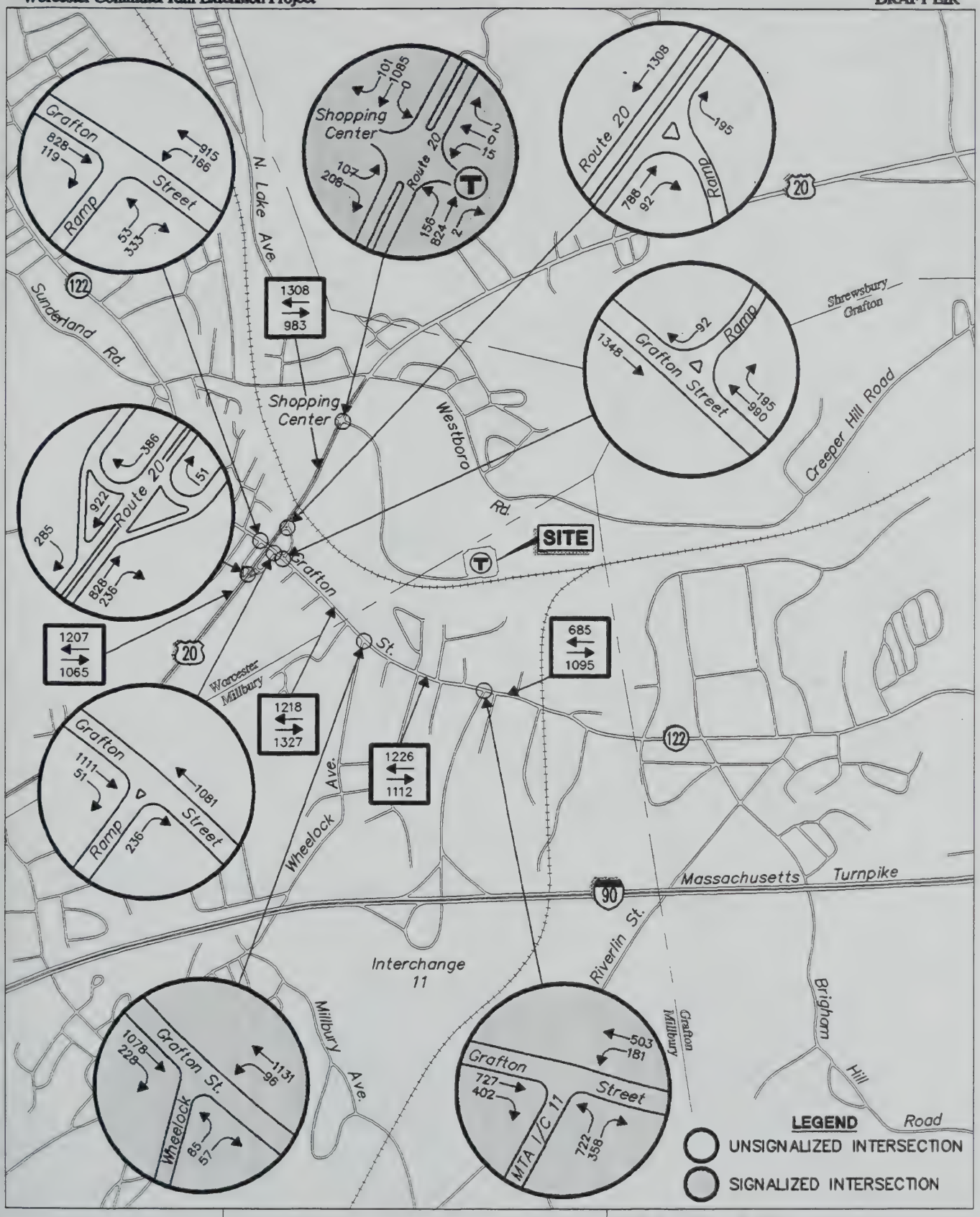
A.M. Peak Hour
7:15 - 8:15 A.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-25



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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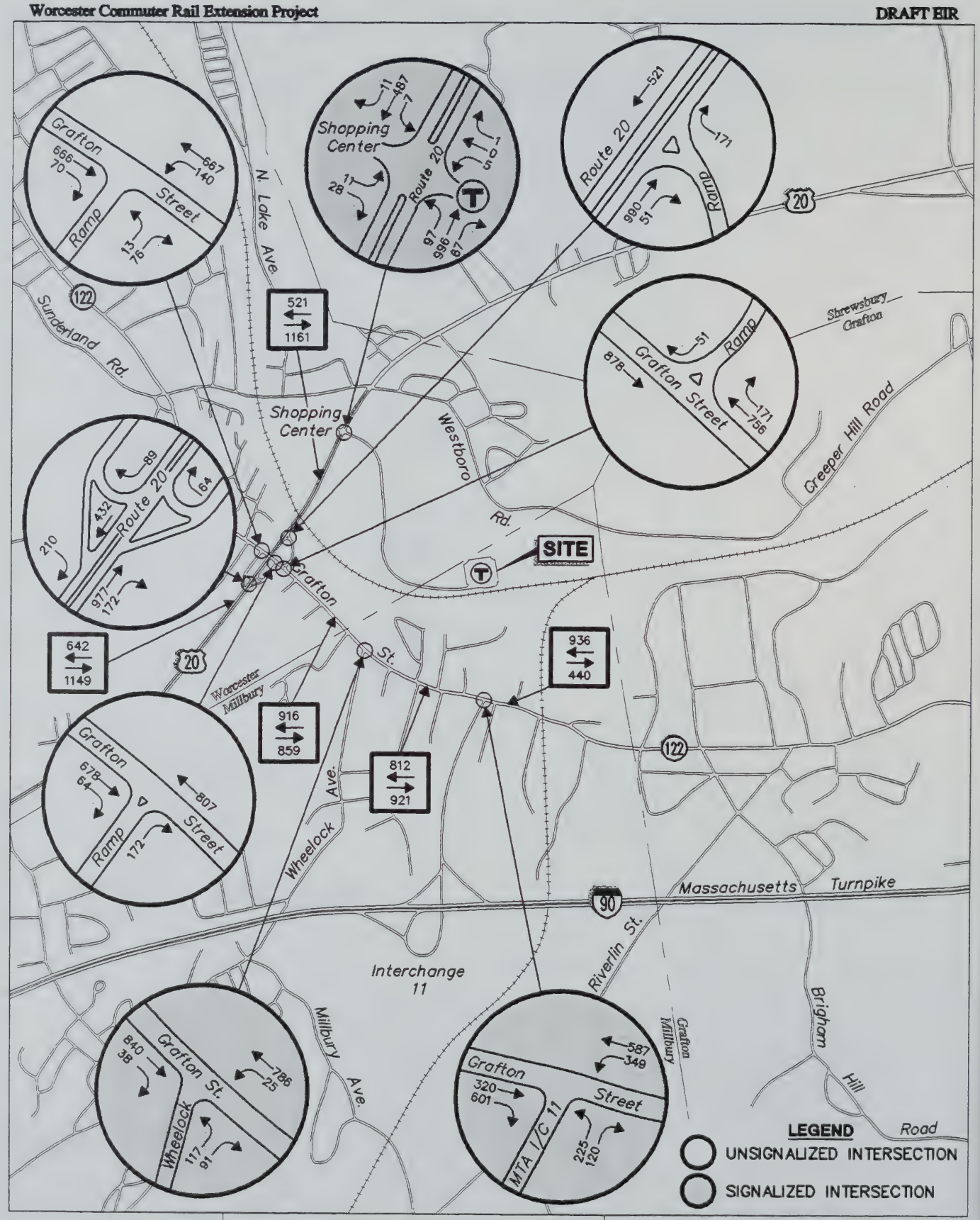
P.M. Peak Hour
5:00 - 6:00 P.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-26



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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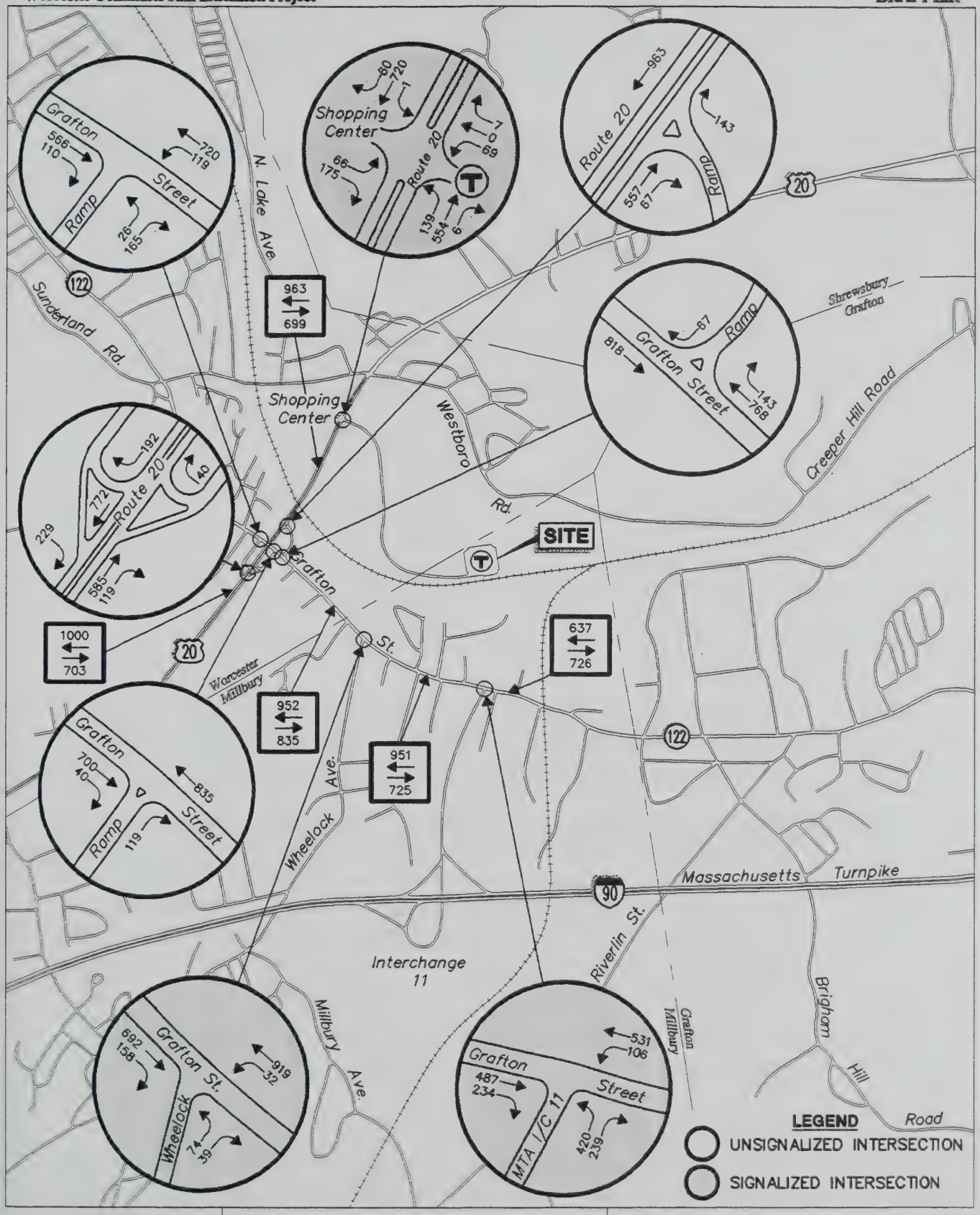
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Generator Hour
6:00 - 7:00 P.M.
2001 BUILD ALL STATIONS
Millbury Station - Route 20

FIGURE 1.4-28

Table 1.4-24 2001 Peak Hour Signalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	B(6.2)	F(68.7)	B(6.2)	F(65.3)
Eastbound	A(2.7)	C(17.8)	A(2.7)	C(15.4)
Westbound	B(5.2)	F(82.8)	B(5.2)	E(41.0)
Northbound	B(13.2)	F(102.6)	B(13.3)	F(133.8)
Route 122 and Wheelock**	A(3.0)	B(10.6)	A(2.9)	B(10.3)
Eastbound	A(2.0)	A(1.5)	A(2.0)	A(1.5)
Westbound	A(2.3)	C(15.5)	A(2.3)	B(14.7)
Northbound	B(9.7)	E(43.8)	B(9.9)	E(43.8)
Route 20 and Mall**	-	-	A(8.2)	B(13.6)
Eastbound	-	-	A(6.5)	B(11.0)
Westbound	-	-	B(10.4)	B(13.4)
Northbound	-	-	D(26.1)	C(24.6)
Southbound	-	-	D(26.3)	C(22.0)

LOS (Average Vehicle Stopped Delay in Seconds)

** Optimized signal timings were used for analysis

Under the 2001 "Build" condition the Route 122/Wheelock Avenue intersection and the Route 20/Mall intersection will operate at overall acceptable level of service ratings. The Route 122/Exit 11 intersection will operate at an unacceptable level of service rating of "F" during the P.M. peak hour. The westbound movement at Exit 11 will operate at LOS "E". The northbound movement at Wheelock Avenue will also operate at LOS "E". The northbound movement at the Route 122/Exit 11 intersection will operate at unacceptable LOS "F" in the P.M. peak hour.

No peak hour level of service reductions will result at the signalized intersections from the traffic entering or exiting the commuter rail station.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-25 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak traffic hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, most of the analyzed intersection movements in the "No Build" condition are operating at acceptable level of service ratings. Traffic turning from westbound Route 20 to Grafton Street operates at LOS "E" in the A.M. peak hour. Traffic turning from eastbound Route 20 to southbound Grafton Street operates at LOS "E" in the P.M. peak hour and traffic turning from the mall to eastbound Route 20 operates at LOS "E" into the P.M. peak hour.

The following intersection movements operate at unacceptable LOS "F".

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.
- All the NB traffic from the Truck Business in the P.M. peak hour.

Most of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings. Traffic turning from eastbound Route 20 to southbound Grafton Street operates at LOS "E" into the P.M. peak hour.

The following intersection movements operate at unacceptable LOS "F":

- The traffic turning left or right from WB Route 20 to Grafton St. in the P.M. peak hour.

No peak hour level of service rating reductions will result at the unsignalized intersections from the traffic entering or exiting the commuter rail station, except for the following intersection movements:

- Left turning traffic from NB Grafton Street to WB Route 20 in the A.M., "B" to "C".
- Left and right turning traffic from WB Route 20 to Grafton Street in the A.M., "E" to "F".

Table 1.4-25 2001 Peak Hour Unsignalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(325)	C(203)	B(325)	C(210)
LT and RT from Ramp	E(16)	F(-316)	E(12)	F(-317)
SB Grafton and Route 20 East				
RT from Ramp	C(239)	E(18)	C(272)	E(18)
NB Grafton and Route 20 East				
RT from Ramp	C(232)	D(178)	C(231)	D(182)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(450)	D(153)	A(453)	D(157)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	B(359)	A(475)	B(345)	A(475)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	C(292)	B(393)	C(271)	B(397)
Route 20 and Mall				
LT from EB Route 20	B(375)	E(79)	-	-
LT from WB Route 20	D(199)	B(349)	-	-
All from Truck Business	A(421)	F(-7)	-	-
RT from Mall	A(619)	C(247)	-	-

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.4-26 lists the results of the analysis of the A.M. and P.M. peak hours.

As shown in the table, four of the analyzed roadway segments are operating in the "No Build" condition at a peak hour level of service rating of "E". Of the roadway segments operating at level of service rating "E" the following have unacceptable reserve capacity in the peak hours:

- Route 122 North of Exit 11 in the A.M. and P.M. Peak Hours.
- Route 122 North of Wheelock in the A.M. and P.M. Peak Hours.
- Route 20 West of Grafton St. in the A.M. and P.M. Peak Hours.

As shown in the table, four of the analyzed roadway segments are operating in the "Build" condition at a peak hour level of service rating of "E". Of the roadway segments operating at level of service rating "E" the following have unacceptable reserve capacity in the peak hours:

- Route 122 North of Exit 11 in the P.M. Peak Hour.
- Route 122 North of Wheelock in the A.M. and P.M. Peak Hours.
- Route 20 West of Grafton St. in the A.M. and P.M. Peak Hours.

No peak hour level of service reductions will result in the roadway segments from the traffic entering or exiting the commuter rail station. The "Build" condition will result in minor reductions in reserve capacity.

Table 1.4-26 2001 Peak Hour Road Segment Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(838)	E(652)	E(839)	E(654)
Route 122 North of Exit 11	E(577)	E(220)	E(600)	E(251)
Route 122 North of Wheelock	E(460)	E(22)	E(481)	E(35)
Route 20 West of Route 122	E(153)	E(280)	E(131)	E(277)
EB Route 20 West of Mall	B(1897)	A(2301)	B(1820)	A(2294)
WB Route 20 West of Mall	A(2408)	B(2114)	A(2404)	B(2046)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 Peak Generator Hour Level Of Service

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-27 lists the results of the signalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 2001 "No Build" and "Build" conditions.

Under the 2001 "No Build" conditions both intersections will operate at overall acceptable level of service ratings. None of the individual movements will see excessive delay.

Table 1.4-27 2001 Peak Generator Hour Signalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 and Exit 11**	A(4.7)	B(8.8)	A(4.7)	B(7.8)
Eastbound	A(2.3)	B(7.8)	A(2.3)	B(7.8)
Westbound	A(3.9)	B(8.2)	A(3.9)	B(8.2)
Northbound	B(10.8)	B(10.2)	B(10.8)	B(7.4)
Route 122 and Wheelock**	A(2.9)	A(2.3)	A(3.8)	A(2.3)
Eastbound	A(2.1)	A(1.4)	A(1.4)	A(1.4)
Westbound	A(2.2)	A(1.8)	A(1.5)	A(1.7)
Northbound	B(9.4)	C(15.3)	C(22.9)	C(15.3)
Route 20 and Mall**	-	-	B(7.3)	B(11.0)
Eastbound	-	-	B(5.8)	B(6.2)
Westbound	-	-	B(10.1)	B(10.9)
Northbound	-	-	D(26.1)	D(39.6)
Southbound	-	-	B(14.7)	C(17.4)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Under the 2001 "Build" conditions all three signalized intersections will operate at overall acceptable level of service ratings. None of the individual movements will see excessive delay.

No reduction peak hour level of service will result at the signalized intersections from the traffic entering or exiting the commuter rail station, except for the northbound movement at Wheelock Avenue which will experience a reduction in level of service rating from "B" to "C" in the A.M. peak generator hour.

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.4-28 lists the results of the unsignalized intersection analysis for the A.M. and P.M. peak generator traffic hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, all of the analyzed intersection movements in the "No Build" condition are operating at acceptable level of service ratings. The traffic turning left

or right from westbound Route 20 to Grafton Street in the P.M. peak hour is at LOS "E". All the northbound traffic from the Truck Business in the A.M. and P.M. peak hour is at LOS "E".

All of the analyzed intersection movements in the "Build" condition are operating at acceptable level of service ratings. The traffic turning left or right from WB Route 20 to Grafton St. in the A.M. and P.M. peak hours is at LOS "E". Traffic turning from WB Route 20 to Grafton Street experiences a reduction in level of service, from LOS "D" to LOS "E" in the A.M. peak generator hour "Build" condition.

Table 1.4-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Grafton and Route 20 West				
LT from NB Grafton	B(351)	B(383)	B(351)	A(413)
LT and RT from Ramp	D(100)	E(70)	E(93)	E(33)
SB Grafton and Route 20 East				
RT from Ramp	C(244)	B(342)	C(282)	B(338)
NB Grafton and Route 20 East				
RT from Ramp	B(332)	B(304)	B(331)	B(326)
WB Route 20 and Grafton				
RT from Ramp to WB 20	A(531)	B(325)	A(533)	B(330)
EB Route 20 and SB Grafton				
RT from Ramp to EB 20	A(448)	A(629)	A(431)	A(626)
EB Route 20 and NB Grafton				
RT from Ramp to EB 20	B(383)	A(549)	B(357)	A(554)
Route 20 and Mall				
LT from EB Route 20	A(454)	C(260)	-	-
LT from WB Route 20	C(267)	A(506)	-	-
All from Truck Business	E(82)	E(72)	-	-
RT from Mall	A(664)	A(417)	-	-

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.4-29 lists the results of the analysis of the A.M. and P.M. peak generator hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, four of the analyzed roadway segments are operating in the "No Build" condition at the peak hour level of service rating of "E". However, only one segment operating at level of service rating "E" has an unacceptable reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton St. in the A.M. Peak Generator Hour.

As shown in the table, four of the analyzed roadway segments are operating in the "Build" condition at the peak generator hour level of service rating of "E". However, only one segment operating at level of service rating "E" has an unacceptable reserve capacity. The roadway segment which has an unacceptable reserve capacity in the peak generator hours is as follows:

- Route 20 West of Grafton St. in the A.M. Peak Generator Hour.

No significant reductions peak generator hour level of service will result in the roadway segments from the traffic entering or exiting the commuter rail station.

Table 1.4-29 2001 Peak Generator Hour Road Segment Level of Service

Millbury (Route 20)	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 122 South of Exit 11	E(935)	D(1246)	E(936)	D(1246)
Route 122 North of Exit 11	E(677)	E(762)	E(770)	E(840)
Route 122 North of Wheelock	E(731)	E(716)	E(742)	E(789)
Route 20 West of Route 122	E(419)	E(727)	E(395)	E(638)
EB Route 20 West of Mall	B(2131)	A(2485)	B(2064)	A(2478)
WB Route 20 West of Mall	A(2387)	A(2301)	A(2373)	A(2247)

Year 2001 "Ten Percent of Traffic" Analysis

The Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds

ten percent of the projected "Build" traffic volumes. Table 1.4-30 lists the site generated traffic as a percentage of the total traffic at the various intersections and road segments analyzed within the study area during the year 2001 A.M. and P.M. peak hours.

As shown in the Table none of the intersections or road segments analyzed exceed the 10 percent requirement.

Table 1.4-30 2001 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Route 122 and Exit 11	0.0%	0.0%
Route 122 and Wheelock	0.2%	0.0%
Route 122 NB and EB 20 Ramp	0.2%	0.0%
Route 122 SB and EB 20 Ramp	0.4%	0.0%
Route 122 and WB Route 20 Ramp	0.5%	0.1%
Route 20 EB and SB 122 Ramp	3.8%	0.2%
Route 20 EB and NB 122 Ramp	4.2%	0.2%
Route 20 WB and Route 122 Ramp	0.6%	0.9%
Route 20 and Mall and Driveway	3.6%	0.8%
Roadway Segment		
Route 122 South of Exit 11	0.0%	0.0%
Route 122 North of Exit 11	0.0%	0.0%
Route 122 North of Wheelock	0.3%	0.0%
Route 20 West of Route 122	2.4%	0.7%
Route 20 West of Mall	3.3%	0.7%

Site generated traffic as a percentage of total traffic

Summary of Findings

The basic findings of the traffic analysis for the Millbury Commuter Rail Station with access from Route 20, are that generally the streets and intersections within the study area operate acceptably in both the "No Build" and "Build" conditions.

Traffic turning from westbound Route 20 to Grafton Street generally operates poorly in the P.M. peak hour existing and "No Build" conditions. This is primarily due to

the substandard design of the interchange. Very little station generated traffic will be added to this movement (2 vehicles in the year 2001). Therefore, construction of the commuter rail station will not significantly impact this intersection.

The intersection of Grafton Street and Exit 11 is expected to deteriorate to LOS "F" by the year 2001 in the P.M. peak hour "No Build" condition. This is due to normal background traffic growth and will occur with or without construction of the proposed station. Construction of the proposed station will not significantly impact operating conditions at the intersection.

In summary, while general improvements to increase capacity are needed on both Route 122 and Route 20, traffic generated by the proposed commuter rail station will not adversely impact the study area roadway network.

1.5 Grafton Station

Project Introduction

The proposed location for the Grafton Commuter Rail station is on the westerly side of Pine Street and approximately 300 feet north of Westborough Road (Route 30). The proposed station is on a portion of the former Grafton State Hospital site. The land is currently owned by the Commonwealth of Massachusetts under jurisdiction of the Division of Capital Planning and Operations (DCPO). Approximately five acres will be deeded to the MBTA. The site consists of approximately two acres of open meadow bordered by wooded areas on the north, east and west.

The proposed station will consist of two 800-foot-long, low-level platforms with 45-foot mini-high platforms for handicapped access, a pedestrian overpass, a drop-off area for Kiss'n'Ride patrons, adequate lighting for public safety and landscaping. The commuter parking lot is proposed to provide 248 parking spaces. The Pine Street bridge will be reconstructed by the Massachusetts Highway Department. The bridge will be located about 75 feet east of the existing bridge and will include an improved intersection with Route 30.

Study Area

The study area for assessment of traffic impacts at this station is focused on roadways which are anticipated to be used as the major access routes. These roadways include:

- Shrewsbury Street/North Main Street (Route 140)
- Worcester Street (Route 122/140)
- Waterville Street (Route 30)
- Westborough Road (Route 30)
- Westborough Road

All of these access routes are two lane roads and are owned and maintained by the Town of Grafton, with the exception of State Route 122. All at-grade intersections are controlled by stop or yield signs; there are no existing traffic signals in the area.

Commuters to downtown Boston currently drive through Grafton on Route 140 or Route 30, then via Route 9 eastbound to the Massachusetts Turnpike at Interchange 12 in Framingham. Some commuters also use Route 122 to access the Turnpike at Interchange 11 in Millbury.

Data Collection

To assess the existing transportation environment, a data collection program was started in October, 1992 and completed in May, 1993. Data items necessary for analysis of operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing and timing, and geometric configuration of roadway links and intersections.

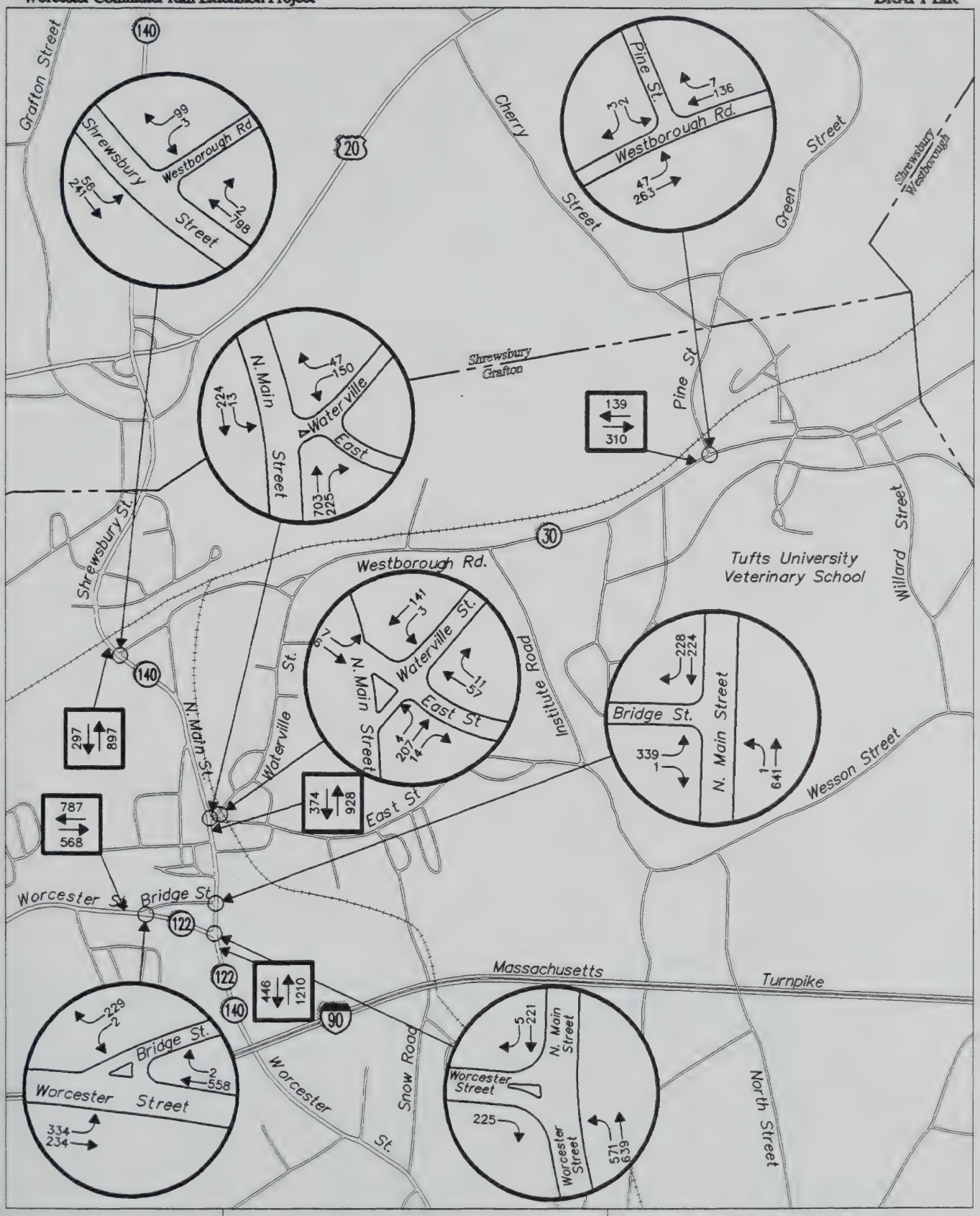
Intersection turning movement counts, used for the existing conditions analysis, were performed at the following intersections on the dates indicated:

	A.M.	P.M.
Shrewsbury Street with Westborough Road	10-6-92	10-5-92
North Main Street with Waterville Street	12-22-92	12-3-92
Waterville Street with East Street	12-22-92	12-3-92
North Main Street with Bridge Street	10-7-92	10-6-92
Worcester Street with Bridge Street	1-6-93	1-6 & 2-11-93
North Main Street with Worcester Street	5-13-93	5-13-93
Westborough Road with Pine Street	5-5-93	5-5-93

Vehicle turning movements at these intersections were observed and recorded from 6:30 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the roadway peak hour volumes, and the volumes during the projected commuter rail station peak generator hours.

Vehicles were classified into two categories: cars and trucks or buses. Volumes were recorded in 15 minute intervals to allow determination of the true peak hour, and calculation of peak hour factors. The 1992 peak hour traffic volumes are shown on Figures 1.5-1 and 1.5-2 for the A.M. and P.M. peak hours respectively. Since peak generator hours for the station's traffic may not coincide with standard peak hours, it is also necessary to analyze the A.M. and P.M. peak generator hours. Figures 1.5-3 and 1.5-4 show 1992 existing traffic volumes during the A.M. and P.M. time periods that correspond to the anticipated future peak generator hours for the commuter rail station.

Intersection geometric configurations were determined through field observations. Geometric elements such as number and use of travel lanes, lane widths, and roadway grades are required for analysis of operational conditions and were observed in the field. The field data sheets for the counts are included in an uncirculated appendix available for review at the MBTA, or at EOEA (MEPA Section).



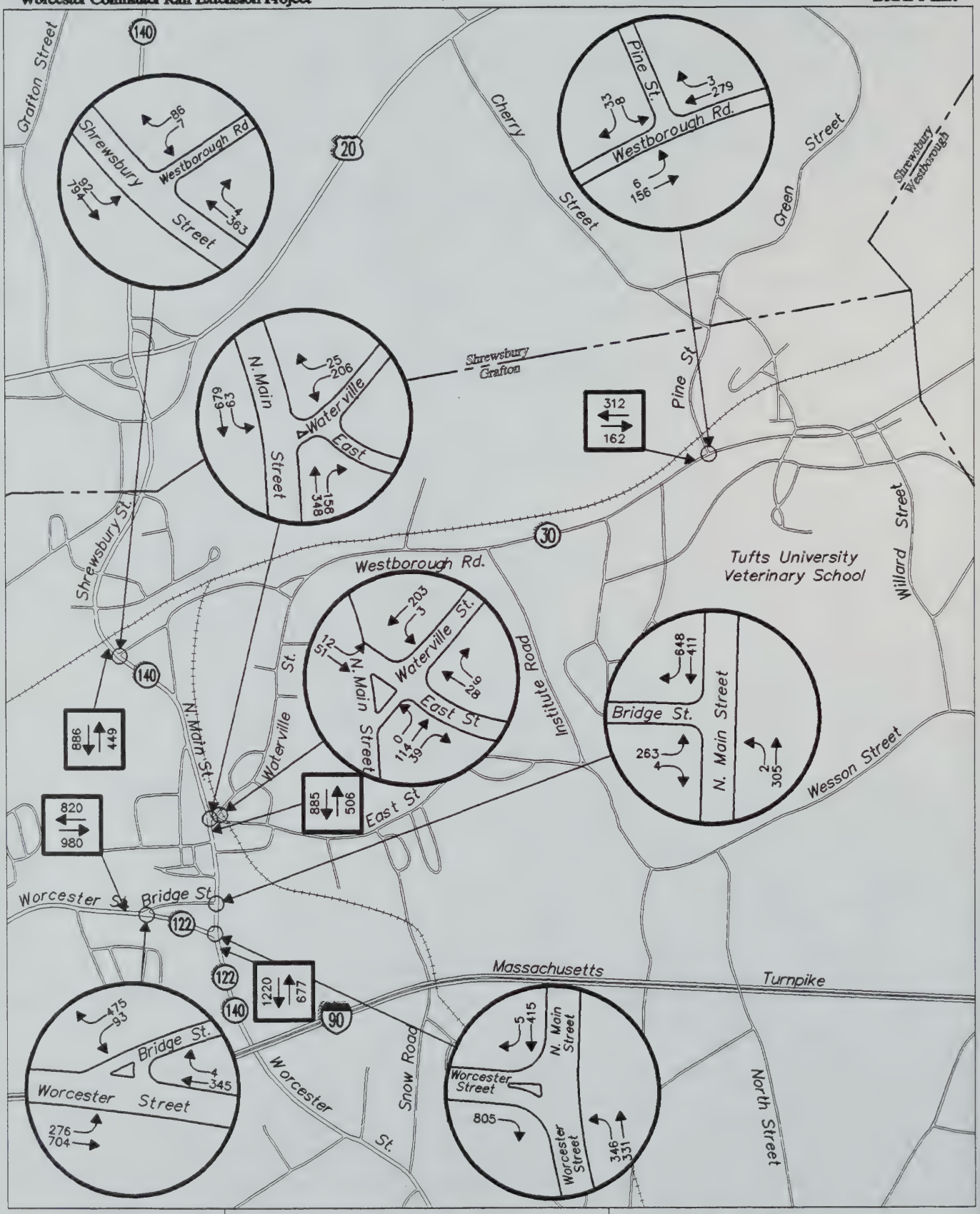
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
1992 Existing Conditions
GRAFTON STATION

FIGURE 1.5-1



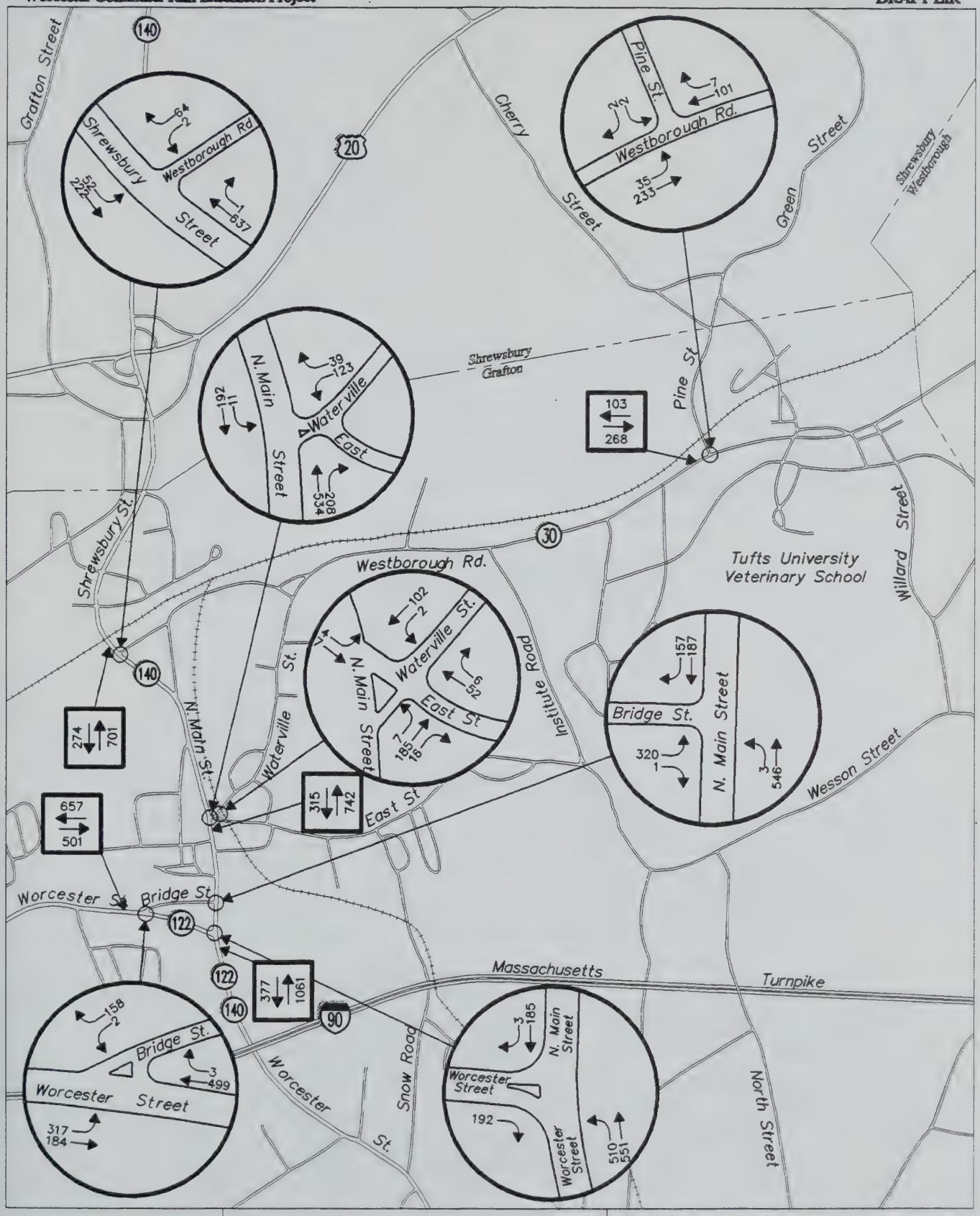
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1992 Existing Conditions
GRAFTON STATION

FIGURE 1.5-2



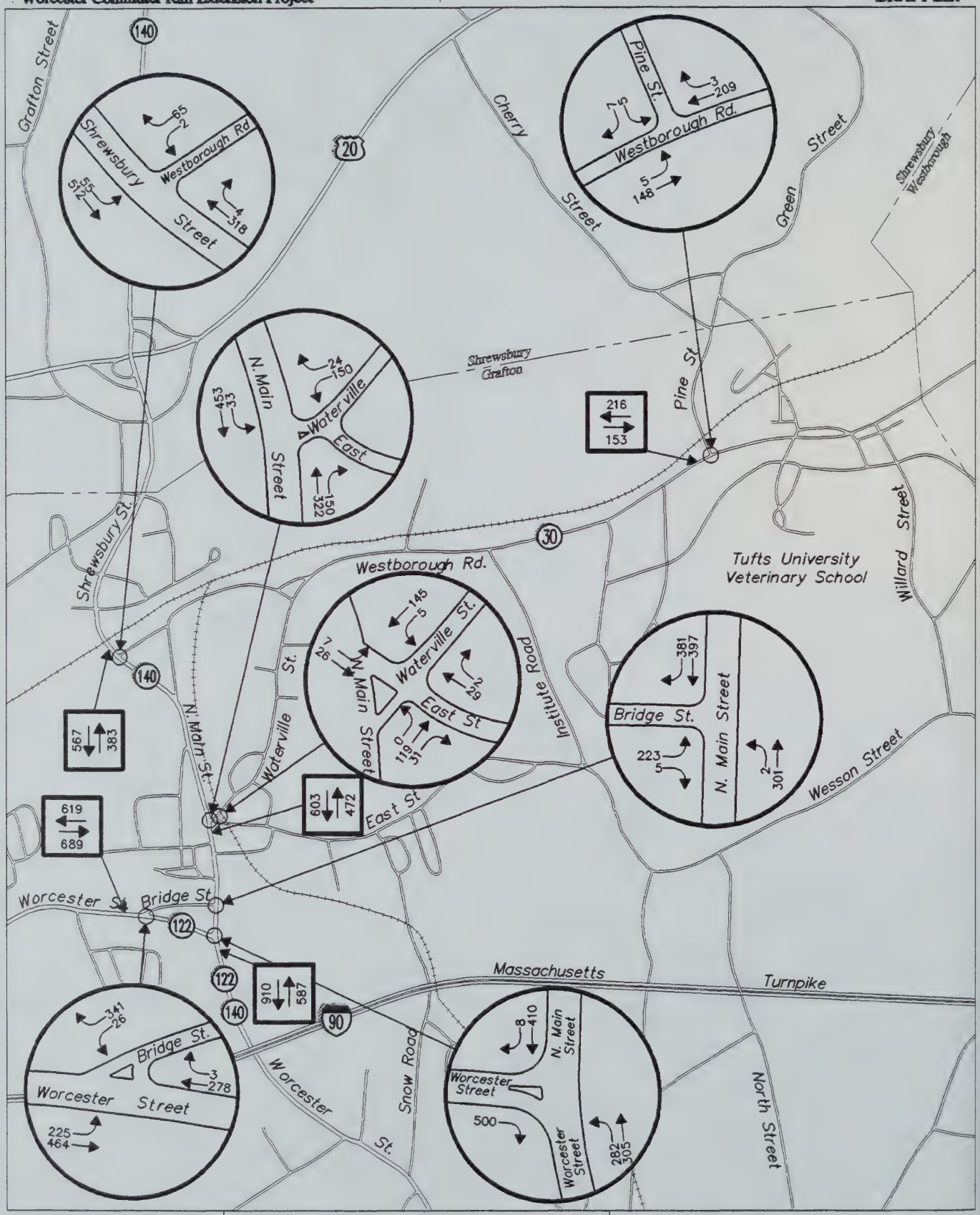
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1992 Existing Conditions
GRAFTON STATION

FIGURE 1.5-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
1992 Existing Conditions
GRAFTON STATION

FIGURE 1.5-4

Year 1992 Existing Conditions

Signalized Intersections

There are no existing traffic signals in the area of study.

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM).* The software program "CINCH" was used to perform the analysis. The computerized output of "CINCH" can be examined in a report available for review at the MBTA, or at EOEA (MEPA Section). A.M. and P.M. analyses were performed for both the intersection peak hour that corresponds to the future site peak generator hour.

As opposed to a signalized intersection, level of service for an unsignalized intersection is stated in terms of reserve capacity. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. A description of level of service is provided in Section 1.1 of this report.

Seven unsignalized intersections were analyzed and include the following:

Shrewsbury Street/Westborough Road Intersection

Westborough Road intersects Shrewsbury Street (Route 140) at 90 degrees forming a "T" intersection. The intersection is located just to the south of the Conrail tracks. Both Shrewsbury Street and Westborough Road are two lane roads. The westbound Westborough Road traffic, which must make either a left or right turn on to Shrewsbury Street from a shared lane, is controlled by a stop sign.

North Main Street/Waterville Street Intersection

Waterville Street (Route 30) intersects North Main Street (Route 140) at an angle forming a "Y" intersection. This is the north side of a "K" type intersection. The south side is the Waterville Street with East Street intersection. The intersection is in the center of North Grafton. Both North Main Street and Waterville Street are two lane roads. The westbound Waterville Street traffic, which must turn left or right onto North Main Street, is controlled by a stop sign.

Waterville Street/East Street Intersection

East Street intersects Waterville Street (Route 30) at 90 degrees forming a "T" intersection and is the southern leg of the "K" type intersection of North Main Street, Waterville Street and East Street. The intersection is located in North Grafton Center and is approximately one car length to the east of the North Main Street/Waterville Street intersection. Both Waterville Street and East Street are two lane roads. The northwestbound East Street traffic turning left or right in a shared lane is controlled from entering Waterville Street by a stop sign.

North Main Street/Bridge Street Intersection

Bridge Street intersects North Main Street (Route 140) at 90 degrees forming a "T" intersection. The intersection is located just to the south of the North Main Street/Waterville Street/East Street intersection in North Grafton Center. Both North Main Street and Bridge Street are two lane roads. The eastbound Bridge Street traffic, which must turn left or right onto North Main Street from a shared lane, is controlled by a stop sign.

Worcester Street/Bridge Street Intersection

Bridge Street intersects Worcester Street (Route 122) at an angle forming a "Y" type intersection. Bridge Street has a large traffic island separating the left turning and right turning traffic. There is a small traffic island separating the left turning traffic from Bridge Street and the traffic from Worcester Street turning into Bridge Street.

At night, the left traffic turning into Bridge Street occasionally hits this small traffic island due to its poor visibility.

Both roads are two lane roads. The left turning traffic from Bridge Street from accessing Worcester Street is controlled by a stop sign. The right turning traffic from Bridge Street to access Worcester Street is controlled by a yield sign.

North Main Street/Worcester Street Intersection

North Main Street (Route 140) intersects Worcester Street (Route 122 and Route 140) where Worcester Street becomes Route 122 to the west. The intersection is a "Y" type intersection. All three legs are two lane roads. Southbound North Main Street traffic access to Worcester Street is controlled by a stop sign.

Westborough Road/Pine Street Intersection

Pine Street intersects Westborough Road (Route 30) at 90 degrees forming a "T" intersection. This intersection is located east of North Grafton Center. Both roads are

two lane roads. The southbound left or right turning traffic from Pine Street is in a shared lane and access to Westborough Road is controlled by a stop sign.

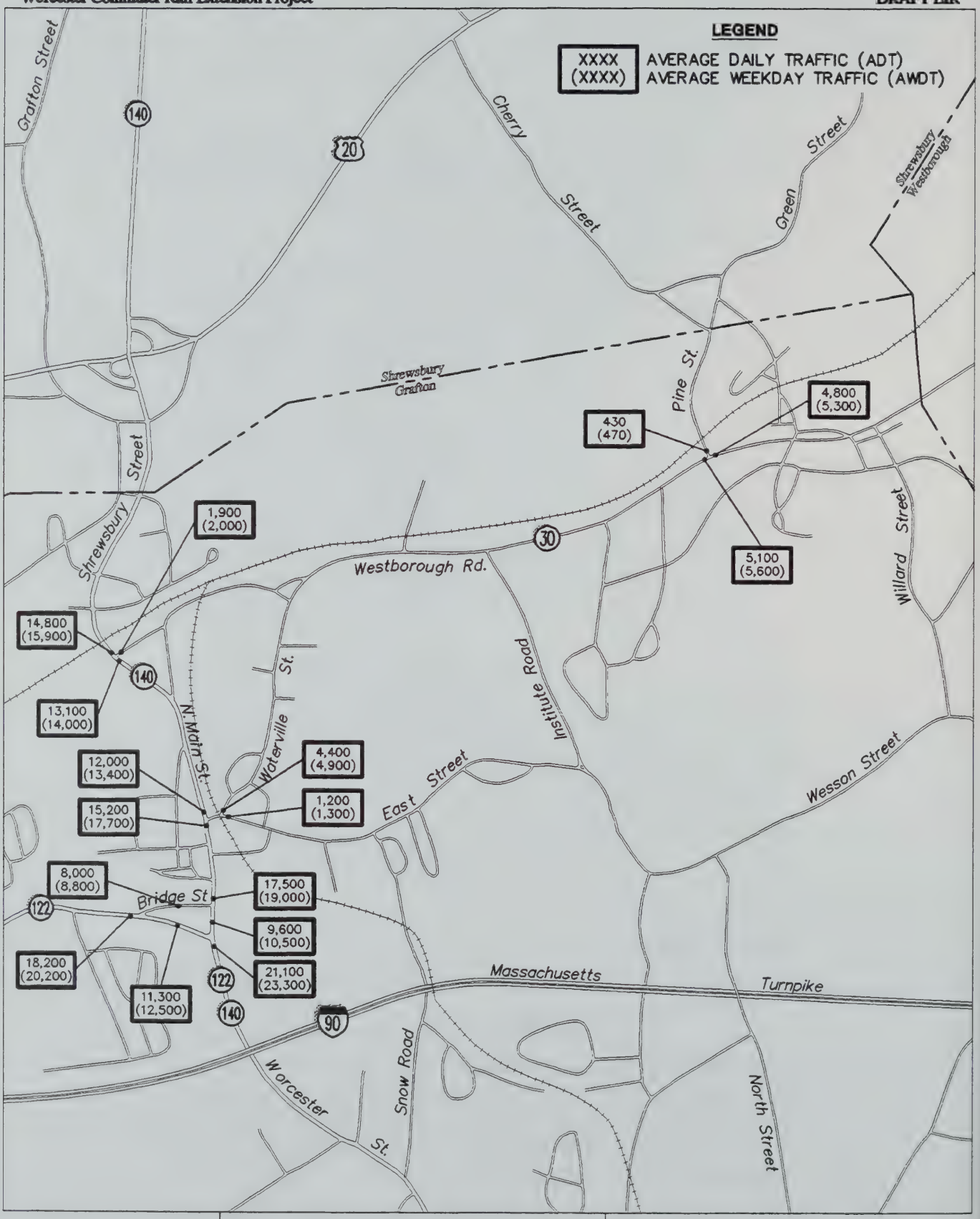
Intersection Levels of Service

Results of the A.M. and P.M. analyses are listed in Table 1.5-1. The table shows the LOS rating as well as the reserve capacity, in vehicles, for each intersection movement. (Only individual movements are assigned LOS ratings; unsignalized intersections cannot be assigned an overall rating.) In the A.M. and P.M. peak hours four of the seven intersections have one movement with a LOS "E" or "F". This is primarily the result of Routes 122 and 140 being the only roads connecting local residential areas and the major local employment areas. During both the A.M. and P.M. roadway peak hours, left and right turns from Waterville Street onto North Main Street operate at LOS "F". Similarly, the turns from Bridge Street onto North Main Street operate at LOS "F". The left turn from Bridge Street onto Worcester operates at LOS "E" in the A.M. peak hour and LOS "F" in the P.M. peak hour. The through movement southbound on Route 140 south of Bridge Street continuing onto Worcester Street (Route 122/140) operates at LOS "F" in both A.M. and P.M. peak hours.

Results of the A.M. and P.M. peak generator hour analyses in Table 1.5-1 shows that four of the seven intersections have one movement with a LOS rating of "E" or "F". Left and right turns from Waterville Street onto North Main Street operate at LOS "E" in the P.M. peak generator hour. Turns from Bridge Street onto North Main Street operate at LOS "F" in both the A.M. and P.M. peaks. The left turn from Bridge Street onto Worcester Street is at LOS "E" in the A.M. peak generator hour. The through movement southbound on Route 140 south of Bridge Street continuing onto Worcester Street (Route 122/140) operates at LOS "F"

Roadway Segments

The average daily traffic (ADT) and average weekday traffic (AWDT) were collected for several streets in the area of the intersections which were analyzed. Figure 1.5-5 presents the 1992 ADT and AWDT volumes. Several roadway segments were analyzed for level of service using the procedures in the 1985 Highway Capacity Manual. Table 1.5-2 lists the results for the A.M. and P.M. peak roadway hours and for the A.M. and P.M. peak generator hours. All roads for all peak hours exhibit excess capacity ranging from 423 vehicles to 2,044 vehicles. Route 122/140 South of Bridge Street has a low LOS "E".



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

1992 Average Daily Traffic & 1992 Average Weekday Traffic GRAFTON STATION

FIGURE 1.5-5

Safety Concerns and Accident History

The Grafton Police Department was contacted on June 21, 1994 to ascertain the existence and location of high frequency accident locations and other safety concerns. Chief Messier indicated two intersections were of particular concern; the intersection of Bridge Street at North Main Street and the intersection of North Main Street at Worcester Street. Preliminary review of accident data supplied by the Department indicates that, in fact, a higher than expected accident rate does occur at these intersections. However, more detailed investigation of the accident history at these locations is required to determine if the small percentage of site generated traffic to be added at these intersections is likely to worsen the existing situation.

Table 1.5-1 1992 Unsignalized Intersection Level of Service

Grafton	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	B(330)	A(591)	A(428)	A(668)
LT and RT from Westborough	D(143)	C(245)	C(257)	A(444)
North Main and Waterville				
LT from SB North Main	B(390)	A(609)	A(497)	A(666)
LT and RT from Waterville	F(-11)	F(-93)	D(108)	E(66)
Waterville and East				
LT from NB Waterville	A(1040)	A(980)	A(1078)	A(1039)
LT from SB Waterville	A(959)	A(1028)	A(980)	A(1029)
THRU and RT from WB East	A(615)	A(648)	A(700)	A(729)
LT and THRU from EB East	A(616)	A(692)	A(664)	A(706)
North Main and Bridge				
LT from NB North Main	A(696)	B(325)	A(785)	A(469)
LT and RT from Bridge	F(-173)	F(-115)	F(-93)	F(-29)
Worcester and Bridge				
LT from SB Worcester	C(270)	A(506)	B(334)	A(617)
LT from Bridge	E(66)	F(-29)	E(95)	D(115)
RT from Bridge	A(470)	A(403)	A(589)	A(605)
North Main and Worcester				
THRU from SB North Main	F(-93)	F(-331)	F(-14)	F(-228)
RT from SB North Main	B(305)	A(523)	B(358)	A(578)
Westborough and Pine				
LT from EB Westborough	A(935)	A(839)	A(984)	A(907)
LT and RT from Pine	A(597)	A(593)	A(617)	A(615)

LOS (Reserve Capacity - Vehicles)

Table 1.5-2 1992 Existing Road Segment Level of Service

Grafton	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	C(1856)	C(1825)	C(1804)	C(2044)
Route 140 North of Westborough	D(1045)	D(1103)	D(1299)	D(1533)
Route 140 South of Route 30	E(720)	E(764)	E(1005)	E(1175)
Route 122 West of Bridge	E(989)	E(686)	D(1247)	E(1165)
Route 122/140 South of Bridge Street	E(482)	E(423)	E(717)	E(875)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. One significant change in traffic control is the anticipated installation of a traffic signal at the intersection of North Main Street (Route 140) and Waterville Street (Route 30). The signal, according to the Massachusetts Highway Department, should be in operation by late 1994 or early 1995.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments proximate to the study area.
- Increases in existing traffic volumes due to population growth and development proximate to, but outside of the study area.

In the Town of Grafton, it was determined that no major new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of 1996 "No Build" condition traffic.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. Analysis of three count locations in Grafton showed an average growth of 0.4% while the local trend station on Route 9 showed an average decline in Traffic of 1.1% over the last three years. This relatively low growth

rate may be due to the economic downturn experienced throughout the region over the past years. Economic indicators point towards a recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

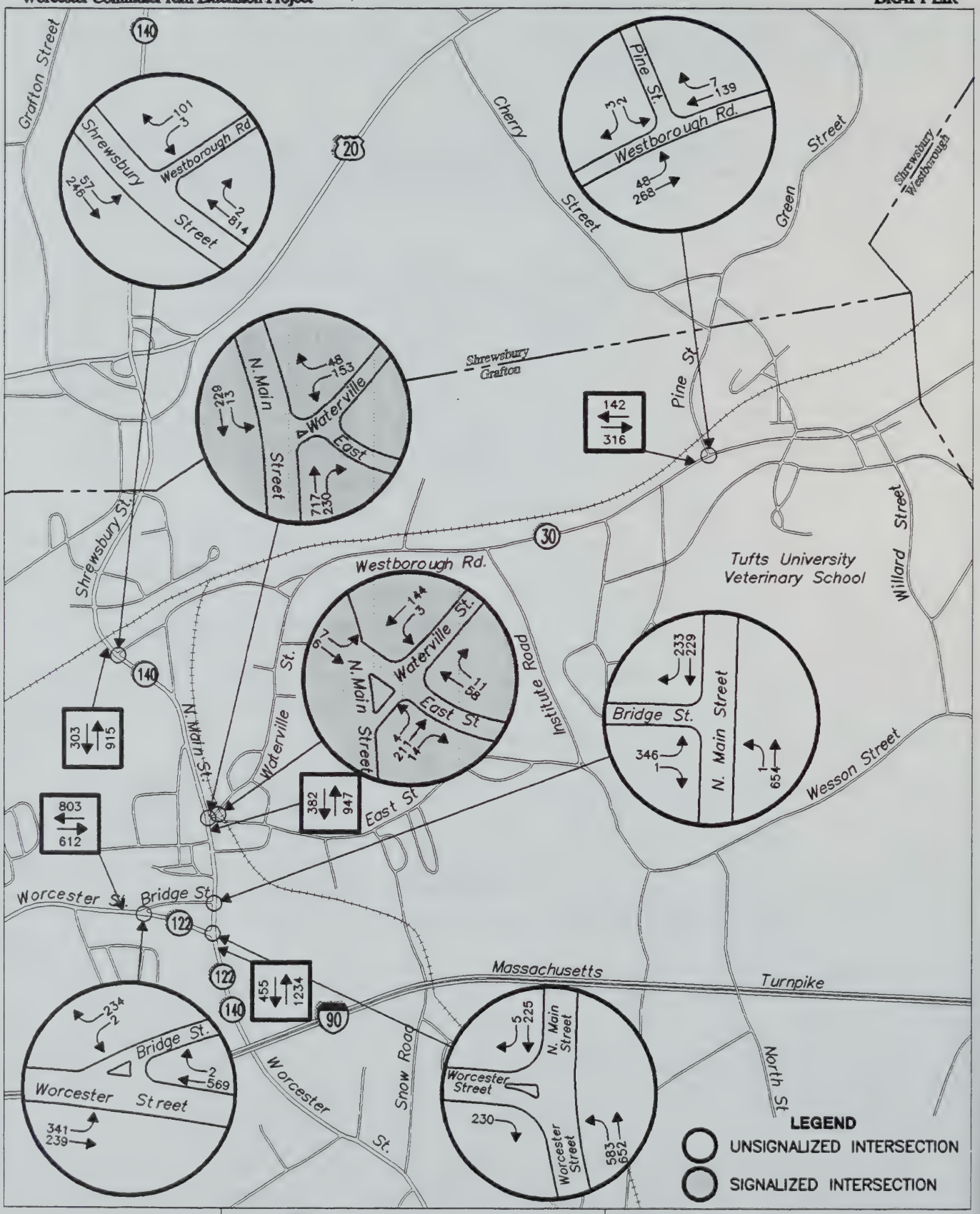
To account for this potential growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5 percent per year was applied to the 1992 existing condition traffic volumes. Figure 1.5-6 shows the projected A.M. peak hour traffic volumes. Figures 1.5-7 shows the projected P.M. peak hour traffic volumes. Figure 1.5-8 shows the A.M. peak generator hour volumes. Figure 1.5-9 shows the P.M. peak generator hour volumes. The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail to Worcester.

Year 1996 Trip Generation/Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 persons are expected to utilize the railroad for daily round trip commuting into Boston.

By 1996, the proposed Grafton Station is projected to attract a total of 115 daily round trip commuters. One hundred six (106) will be Park'n'Ride patrons, while nine will be dropped off at the station.

These patrons are projected to reside in the Towns of Grafton, Shrewsbury, Sutton, Boylston and Northbridge. The number of patrons who originate from each town are shown in Table 1.5-3. The ridership has been adjusted to reflect peak period usage, which is 94% of the total daily demand. These ridership levels are expected to occur shortly after completion of the Grafton Station, therefore, these projections were used in the analysis of the 1996 "Build" conditions.



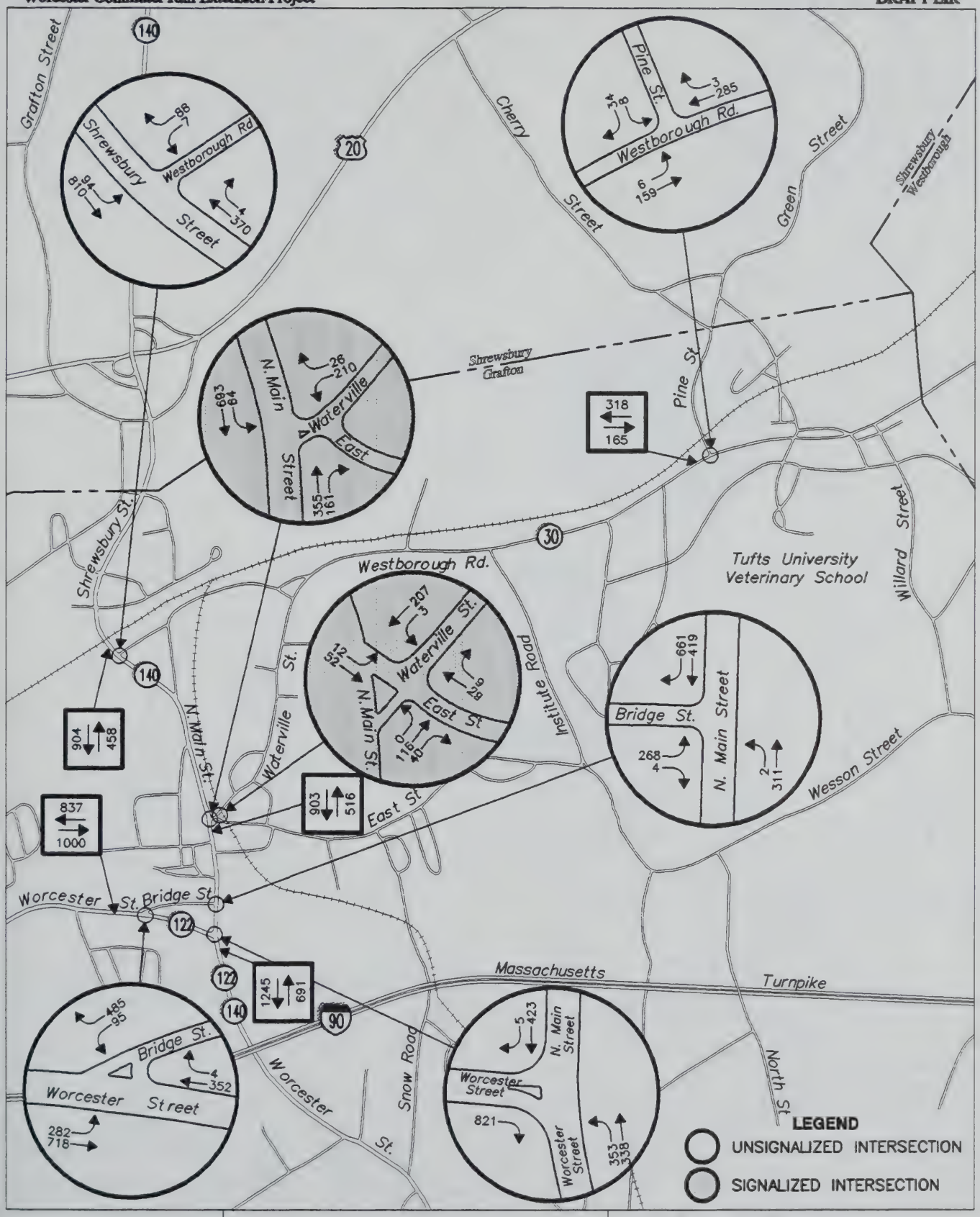
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 NO BUILD
GRAFTON STATION

FIGURE 1.5-6



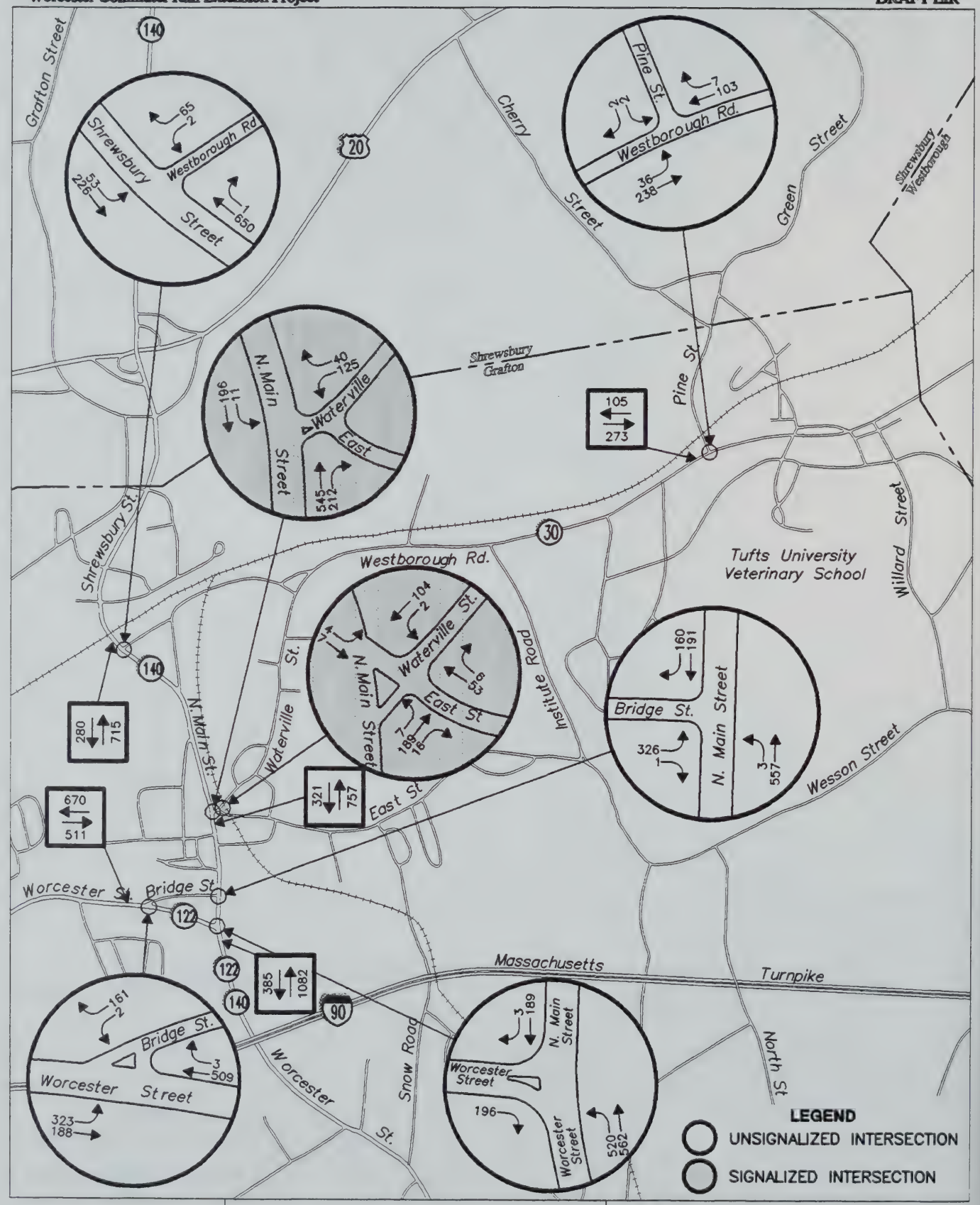
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1996 NO BUILD
GRAFTON STATION

FIGURE 1.5-7



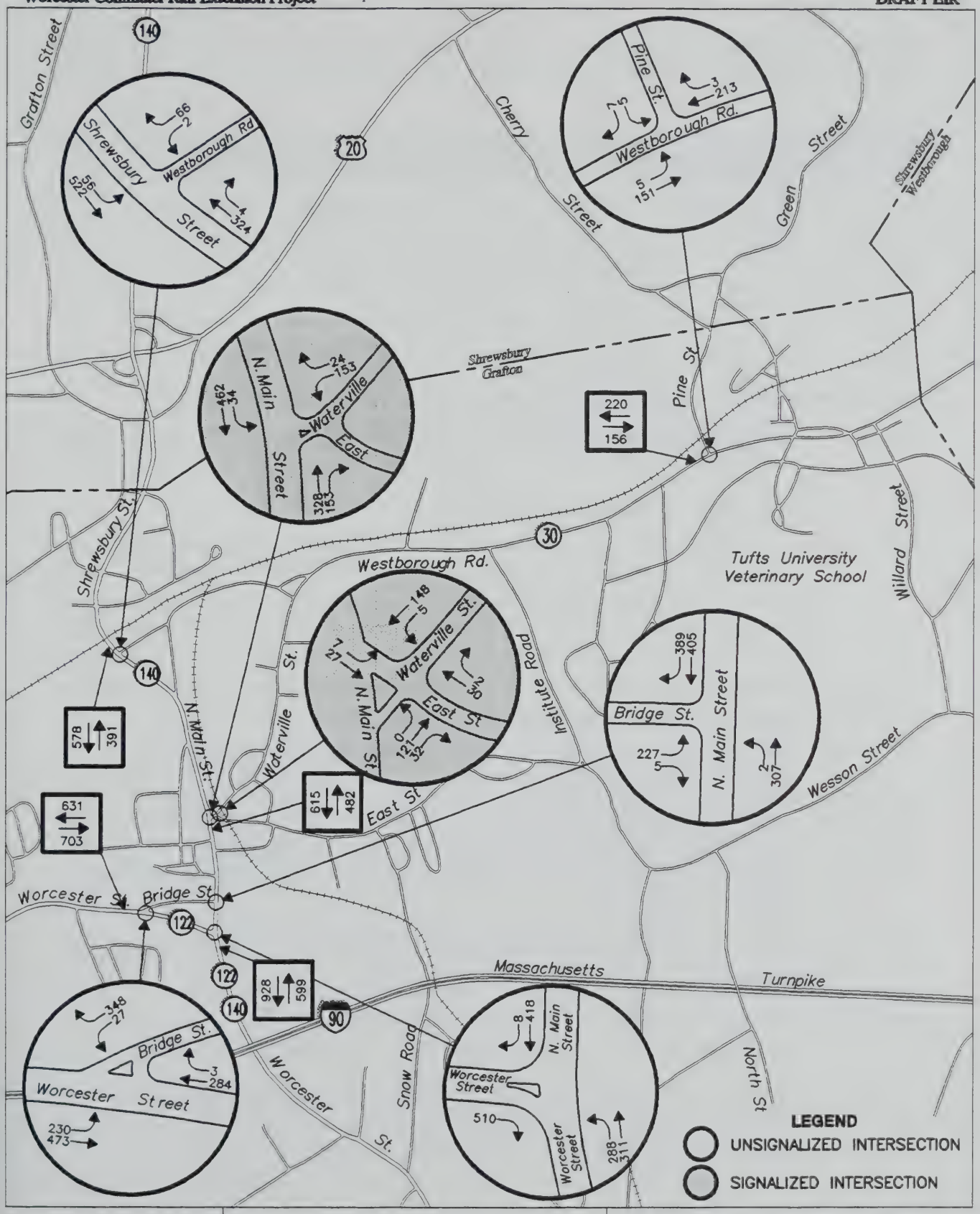
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 NO BUILD
GRAFTON STATION

FIGURE 1.5-8



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
1996 NO BUILD
GRAFTON STATION

FIGURE 1.5-9

Table 1.5-3 Projected Patrons of Grafton Station - Year 1996

Town	Riders*
Grafton	35
Shrewsbury	17
Sutton	15
Boylston	16
Northbridge	26
TOTAL	**109**

* *Adjusted for peak period demand*

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.5-4 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.5-4 MBTA Ridership Distribution at Grafton Station Year 1996	
Inbound Train	**Patrons**
502A	21
504A	35
506A	36
510	17
TOTAL	**109**
Outbound Train	**Patrons**
515A	15
519	25
521	25
521A	39
523	5
TOTAL	**109**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Grafton Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Grafton the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:45 to 5:45 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 5:45 to 6:45 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside

in Grafton would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station. Patrons from Shrewsbury and Boylston would use Route 140 southbound to Westborough Road to Pine Street. From Sutton and Northbridge the route would be northbound on Route 122 and Route 140 to Waterville Street to Westborough Road to Pine Street. Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.5-10 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

Upon completion of the commuter rail service, commuters will shift from automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration.

Year 1996 "Build" Traffic Volumes

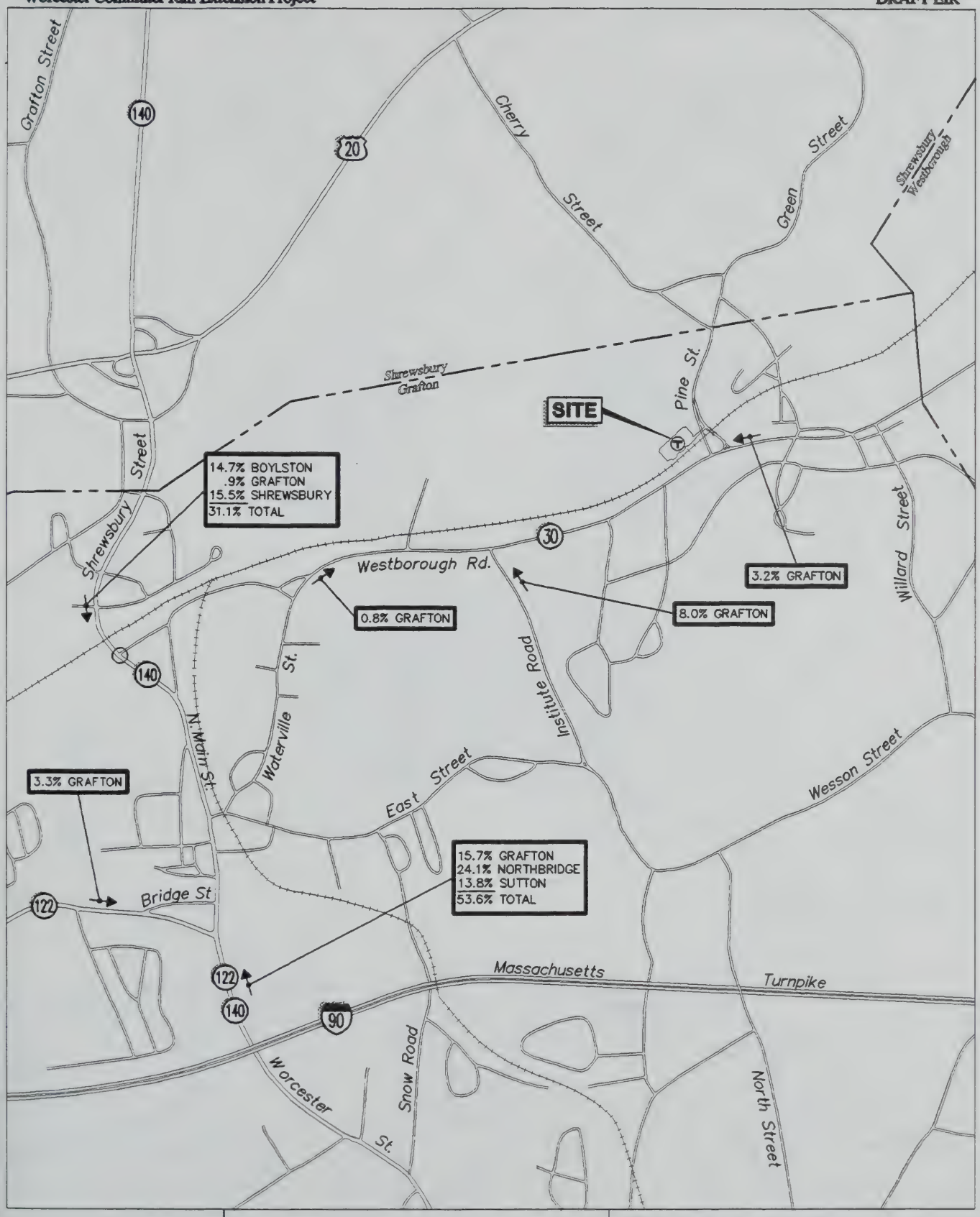
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- the projected year 1996 "No Build" traffic volumes.
- traffic specifically diverted to the proposed Grafton station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Grafton. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways. This results in a "worst case" analysis. Figures 1.5-11 and 1.5-12 show the A.M. and P.M. peak hour traffic volumes, respectively. Figures 1.5-13 and 1.5-14 show the A.M. and P.M. peak generator hour volumes.

Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics, etc. remain unchanged.



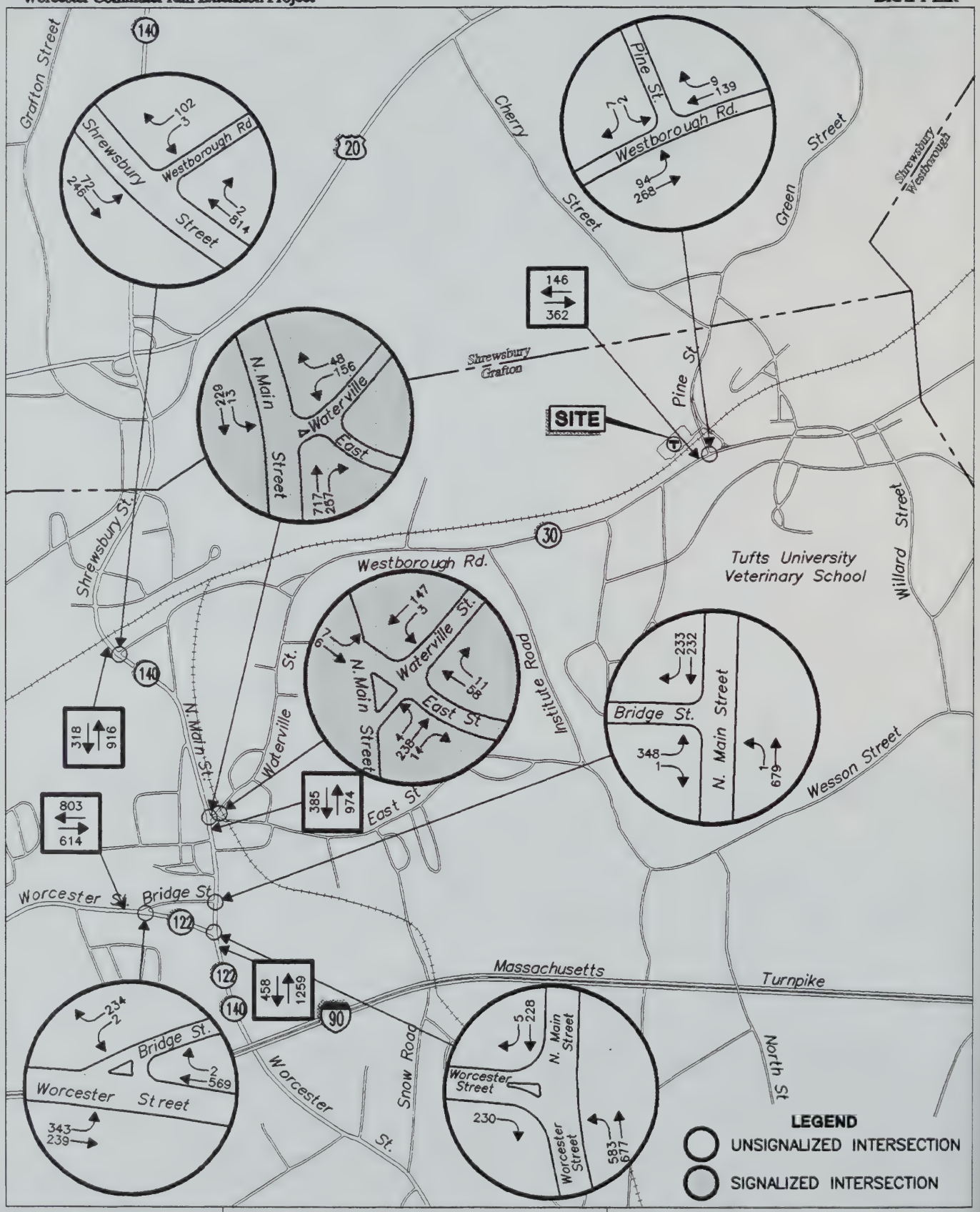
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

Distribution of Commuter Rail Station Traffic 1996 BUILD ALL STATIONS GRAFTON STATION

FIGURE 1.5-10



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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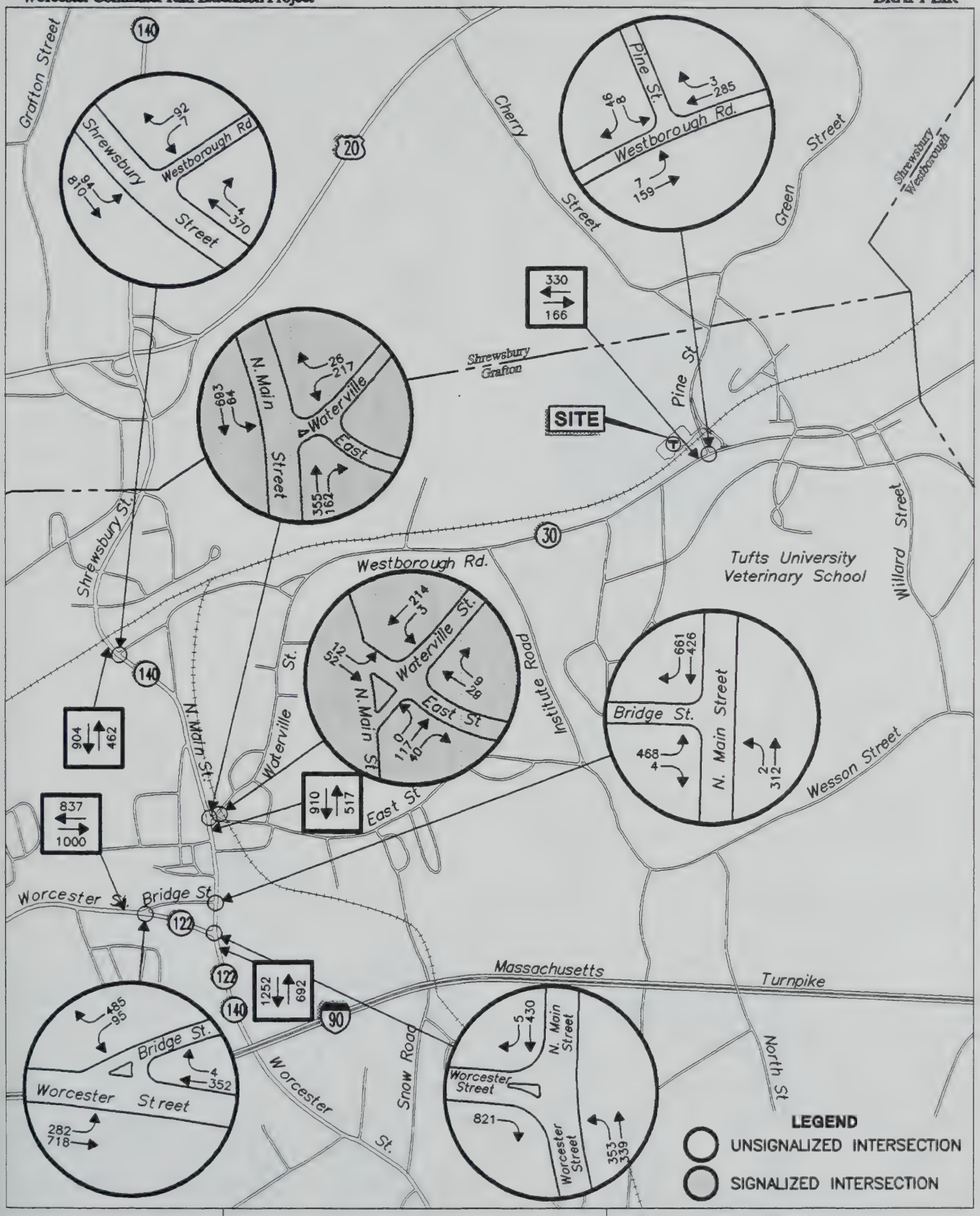
A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-11



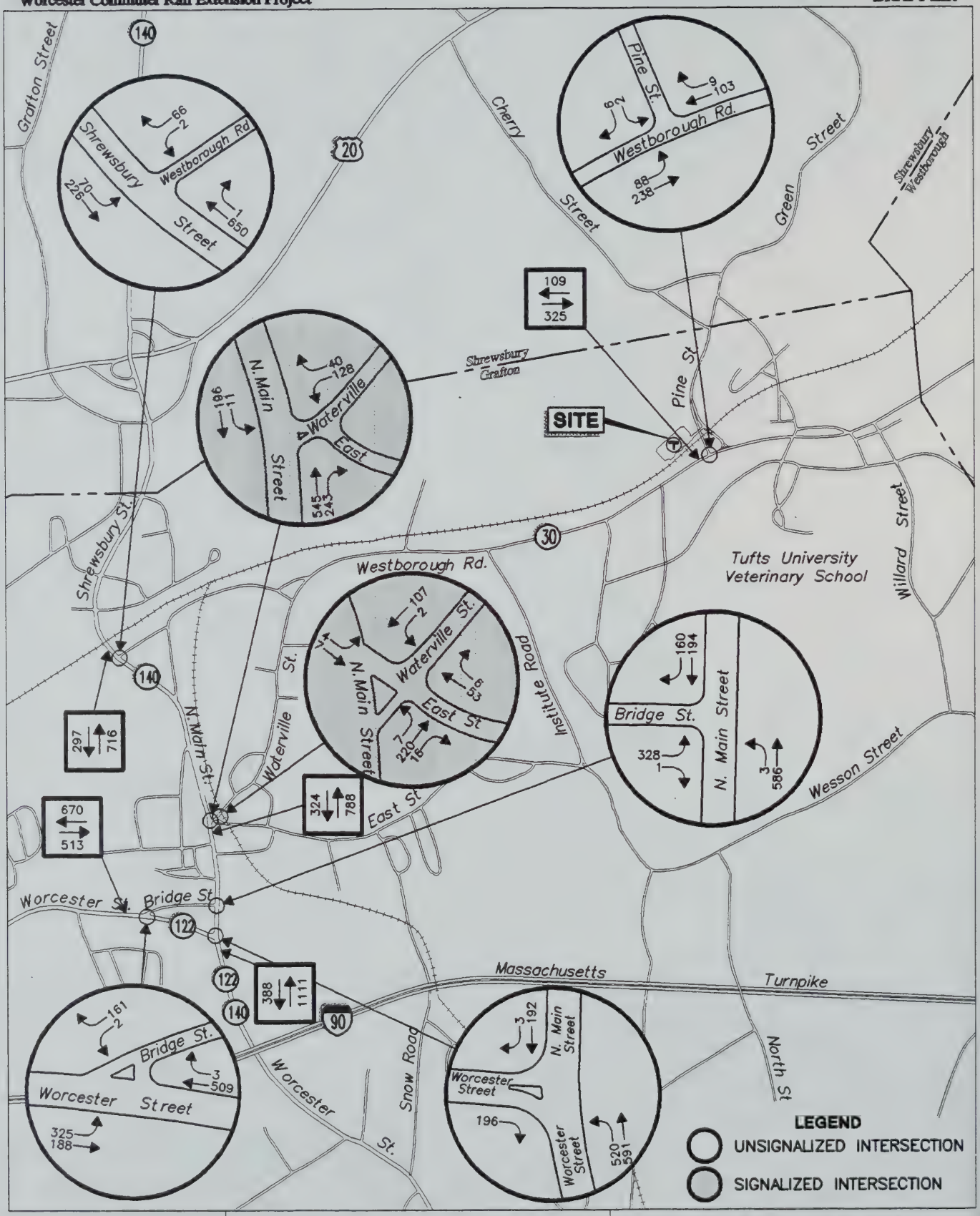
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1996 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-12



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

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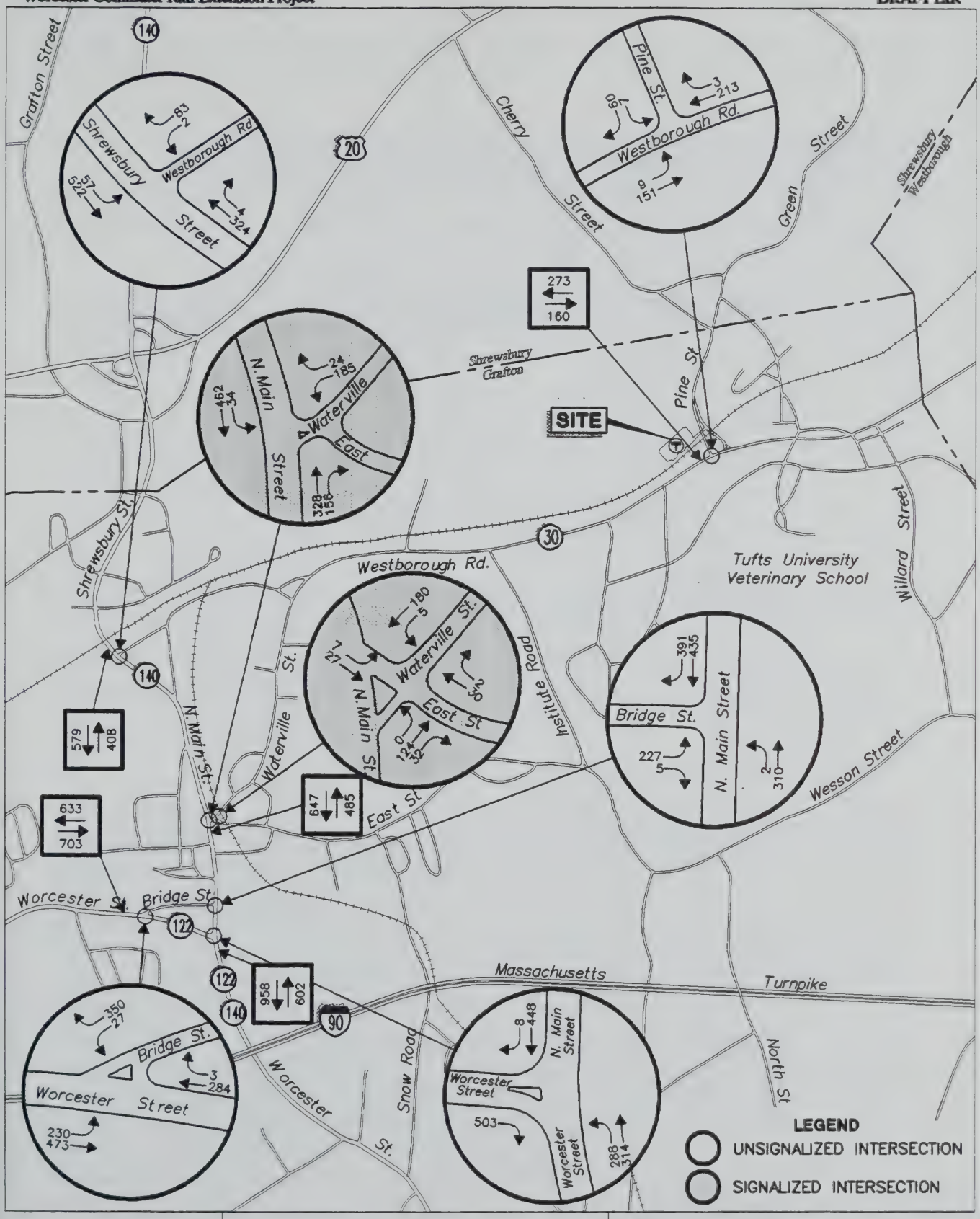
A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
1996 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-14

Signalized Intersections

As the previously noted under 1996 Conditions, a new traffic signal will be in operation at the intersection of North Main/Waterville/East Streets. Results for the A.M. and P.M. peak roadway hours analysis are listed in Table 1.5-5.

Table 1.5-5 1996 Peak Hour Signalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
North Main/Waterville/East Streets	B(12.5)	C(15.9)	B(12.4)	C(16.2)
Eastbound, East Street	D(31.0)	C(25.0)	D(31.0)	C(25.0)
Westbound, Waterville Street	D(36.2)	C(28.2)	D(29.0)	D(30.1)
Northbound	B(9.5)	B(6.5)	B(10.4)	B(6.5)
Southbound	A(4.5)	C(18.5)	A(4.8)	C(18.5)

LOS (Average Vehicle Stopped Delay in Seconds)

The table shows the LOS rating as well as the average delay in seconds per vehicle. In 1996, under the "No Build" and "Build" conditions, all movements would operate at acceptable levels of service.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.5-6. The table shows LOS ratings as well as the reserve capacity, in vehicles, for each intersection movement. Three of the five intersections have one movement with a peak hour LOS "E" or "F". For "No Build," the left and right turns from Bridge Street onto North Main Street operate at LOS "F"; the "Build" condition is virtually the same. The left turn from Bridge Street onto Worcester Street operates at LOS "E" in the A.M. peak hour and LOS "F" in the P.M. peak hour under the "No Build" condition; the "Build" condition is virtually the same. The through movement southbound on Route 140 south of Bridge Street continuing onto Worcester Street (Route 122/140) operates at LOS "F" in both A.M. and P.M. peak hours for the "No Build" condition; the "Build" condition is virtually the same. Overall, the "Build" impacts on the unsignalized intersections are minimal.

Table 1.5-6 1996 Peak Hour Unsignalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	B(320)	A(583)	B(304)	A(583)
LT and RT from Westborough	D(134)	C(236)	D(132)	C(237)
North Main and Bridge				
LT from NB North Main	A(688)	B(316)	A(685)	B(313)
LT and RT from Bridge	F(-186)	F(-126)	F(-197)	F(-128)
Worcester and Bridge				
LT from SB Worcester	C(255)	A(494)	C(253)	A(494)
LT from Bridge	E(61)	F(-35)	E(60)	F(-35)
RT from Bridge	A(456)	B(387)	A(456)	B(387)
North Main and Worcester				
THRU from SB North Main	F(-103)	F(-343)	F(-109)	F(-351)
RT from SB North Main	C(297)	A(516)	C(296)	A(516)
Westborough and Pine				
LT from EB Westborough	A(930)	A(833)	A(881)	A(832)
LT and RT from Pine	A(591)	A(588)	A(650)	A(591)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.5-7 lists the results of this analysis for the A.M. and P.M. peak hours.

All roadway segments will operate at acceptable levels of service for "No Build" and "Build" conditions for A.M. and P.M. peak hours with the exception of Route 122/140 South of Bridge Street which has a low level "E". The "Build" condition results in minor reductions in reserve capacity.

Table 1.5-7 1996 Peak Hour Road Segment Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	C(1828)	C(1815)	C(1744)	C(1788)
Route 140 North of Westborough	D(1019)	D(1074)	D(1019)	E(1070)
Route 140 South of Route 30	E(701)	E(734)	E(654)	E(726)
Route 122 West of Bridge	E(945)	E(636)	D(943)	E(636)
Route 122/140 South of Bridge Street	E(452)	E(382)	E(423)	E(374)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F."

Year 1996 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.5-8 for the 1996 "No Build" and "Build" conditions.

Table 1.5-8 1996 Peak Generator Hour Signalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
North Main/Waterville/East Streets	B(7.9)	B(8.5)	B(8.0)	B(9.2)
Eastbound, East Street	C(17.5)	B(13.7)	C(17.5)	B(13.7)
Westbound, Waterville Street	C(16.8)	C(14.4)	C(17.3)	C(18.4)
Northbound	B(7.0)	B(6.1)	B(7.0)	B(6.2)
Southbound	A(4.4)	B(8.5)	A(4.4)	B(8.5)

LOS (Average Vehicle Stopped Delay in Seconds)

The table shows the LOS rating as well as the average delay in seconds per vehicle. In 1996 for the peak generator hours, all movements for all conditions provide an acceptable level of service. The peak generator hour has significantly less delays than does the peak hour.

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.5-9. The same movements at three of the five intersections which had LOS "E" or "F" under the peak hour analysis also have similar conditions under the peak generator hour. The left and right turns from Bridge Street onto North Main Street operate at LOS "F" for the A.M. and P.M. under "No Build" and "Build," but the reserve capacity is less negative than for the peak hour conditions. The left turn from Bridge Street onto Worcester Street will be LOS "E" in the A.M. and LOS "D" in the P.M. for both "No Build" and "Build". The southbound through movement on Route 140 south of Bridge Street will operate at LOS "F" under all conditions, but is only slightly worse for "Build" versus "No Build."

Table 1.5-9 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	A(419)	A(662)	A(401)	A(661)
LT and RT from Westborough	C(249)	A(438)	C(247)	A(428)
North Main and Bridge				
LT from NB North Main	A(779)	A(459)	A(776)	A(441)
LT and RT from Bridge	F(-106)	F(-40)	F(-120)	F(-51)
Worcester and Bridge				
THRU from SB Waterville	B(320)	A(607)	B(318)	A(607)
LT from Bridge	E(89)	D(108)	E(89)	D(108)
RT from Bridge	A(578)	A(592)	A(578)	A(590)
North Main and Worcester				
THRU from SB North Main	F(-24)	F(-242)	F(-31)	F(-273)
RT from SB North Main	B(350)	A(571)	B(343)	A(570)
Westborough and Pine				
LT from EB Westborough	A(981)	A(903)	A(925)	A(899)
LT and RT from Pine	A(611)	A(610)	A(685)	A(663)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The analysis for the 1996 peak generator hour for roadway segments is presented in Table 1.5-10.

Table 1.5-10 1996 Peak Generator Hour Road Segment Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	C(1783)	C(2026)	C(1676)	C(1909)
Route 140 North of Westborough	D(1271)	D(1513)	D(1268)	D(1511)
Route 140 South of Route 30	E(982)	E(1162)	E(932)	E(1110)
Route 122 West of Bridge	D(1218)	E(1142)	E(1215)	E(1140)
Route 122/140 South of Bridge Street	E(692)	E(831)	E(658)	E(796)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

All roadway segments will operate at acceptable levels of service for "No Build" and "Build" conditions for A.M. and P.M. peak generator hours. The "Build" condition results in minor reductions in reserve capacity. Most reserve capacities are greater than for the peak hour values.

Year 1996 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.5-11 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

Table 1.5-11 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Shrewsbury and Westborough	1.3%	0.3%
North Main and Waterville	2.1%	0.8%
Waterville and East	6.1%	1.7%
North Main and Bridge	2.0%	0.5%
Worcester and Bridge	0.1%	0.0%
North Main and Worcester	1.7%	0.4%
Westborough and Pine	11.1%	2.6%
Roadway Segment		
Route 30 West of Pine	10.9%	2.7%
Route 140 North of Westborough	1.3%	0.3%
Route 140 South of Route 30	2.3%	0.6%
Route 122 West of Bridge	0.1%	0.0%
Route 122/140 South of Bridge Street	1.7%	0.4%

Site generated traffic as a percentage of total traffic

As shown in the table, one intersection and one roadway segment would receive 10 percent or more of their traffic from the proposed Grafton Station during roadway peak hours.

Year 1996 Grafton Station Only

To address an upper limit, worst case situation with regard to traffic impacts on Grafton streets, an analysis was performed which considered that the Grafton commuter station was the only commuter station built by 1996 (in addition to a Worcester Station).

The 1996 "No Build" traffic volumes, for both the peak hours and peak generator hours, were previously presented and serve as the same base for the "Grafton Station Only" as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Grafton Station Only)

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership for the Grafton Station,

employing an unconstrained parking supply. In 1996, the Grafton Station is projected to attract a total of 446 daily round trip commuters, 410 of which would be Park'n'Ride patrons. These patrons are projected to reside in the Towns of Grafton, Upton, Westborough, Northborough, Shrewsbury, Sutton, Boylston, Northbridge, Oxford, Charlton, Millbury, Auburn, and the City of Worcester. The number of patrons who originate from each community are shown in Table 1.5-12. The ridership has been adjusted to reflect peak period usage, which is 94% of the total daily demand.

Table 1.5-12 Projected Patrons of Grafton Station Only Year 1996

City/Town	Riders*
Grafton	38
Upton	28
Westborough	17
Northborough	58
Shrewsbury	84
Sutton	16
Boylston	17
Northbridge	28
Oxford	19
Charlton	17
Millbury	27
Auburn	21
Worcester	48
TOTAL	**418**

* *Adjusted for peak period demand*

Year 1996 Trip Distribution and Assignment (Grafton Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.5-13 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.5-13 MBTA Ridership Distribution - Grafton Station Only Year 1996

Inbound Train	Patrons
502A	82
504A	135
506A	136
510	65
TOTAL	**418**
Outbound Train	**Patrons**
515A	59
519	97
521	97
521A	144
523	21
TOTAL	**418**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Grafton Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute

waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Grafton the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:45 to 5:45 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 6:45 to 7:45 A.M. and from 5:45 to 6:45 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Grafton would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station. Actual routing was based on shortest travel time and distance from population centers. Figure 1.5-15 shows the percentage of station related traffic utilizing the study area roadways.

Year 1996 "Build" Traffic Volumes (Grafton Station Only)

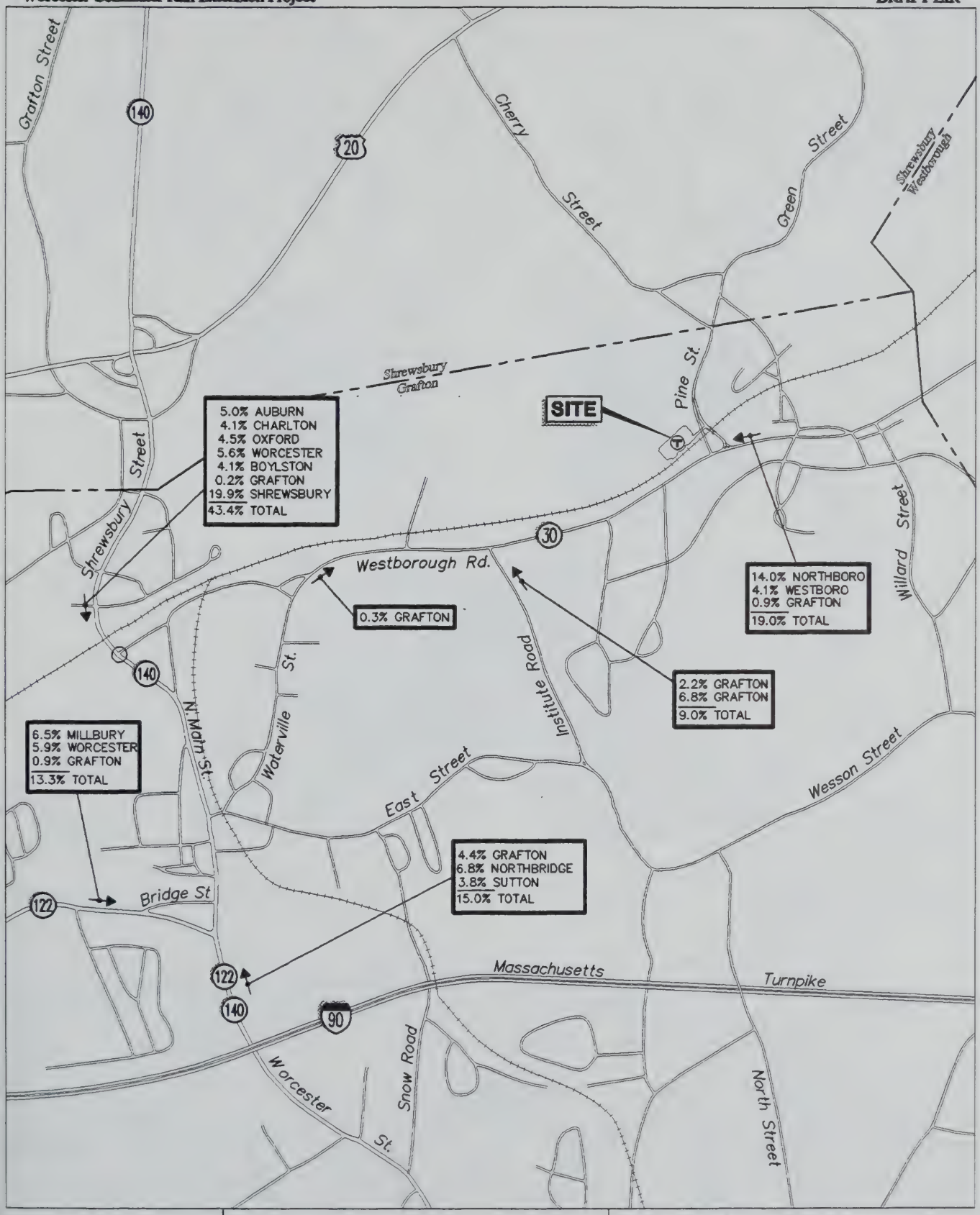
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Grafton station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Grafton. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways. This results in a "worst case" analysis. Figures 1.5-16 and 1.5-17 show the A.M. and P.M. peak hour traffic volumes, respectively. Figures 1.5-18 and 1.5-19 show the A.M. and P.M. peak generator hour volumes.

Year 1996 Peak Hour Level of Service (Grafton Station Only)

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics, etc. remain unchanged.



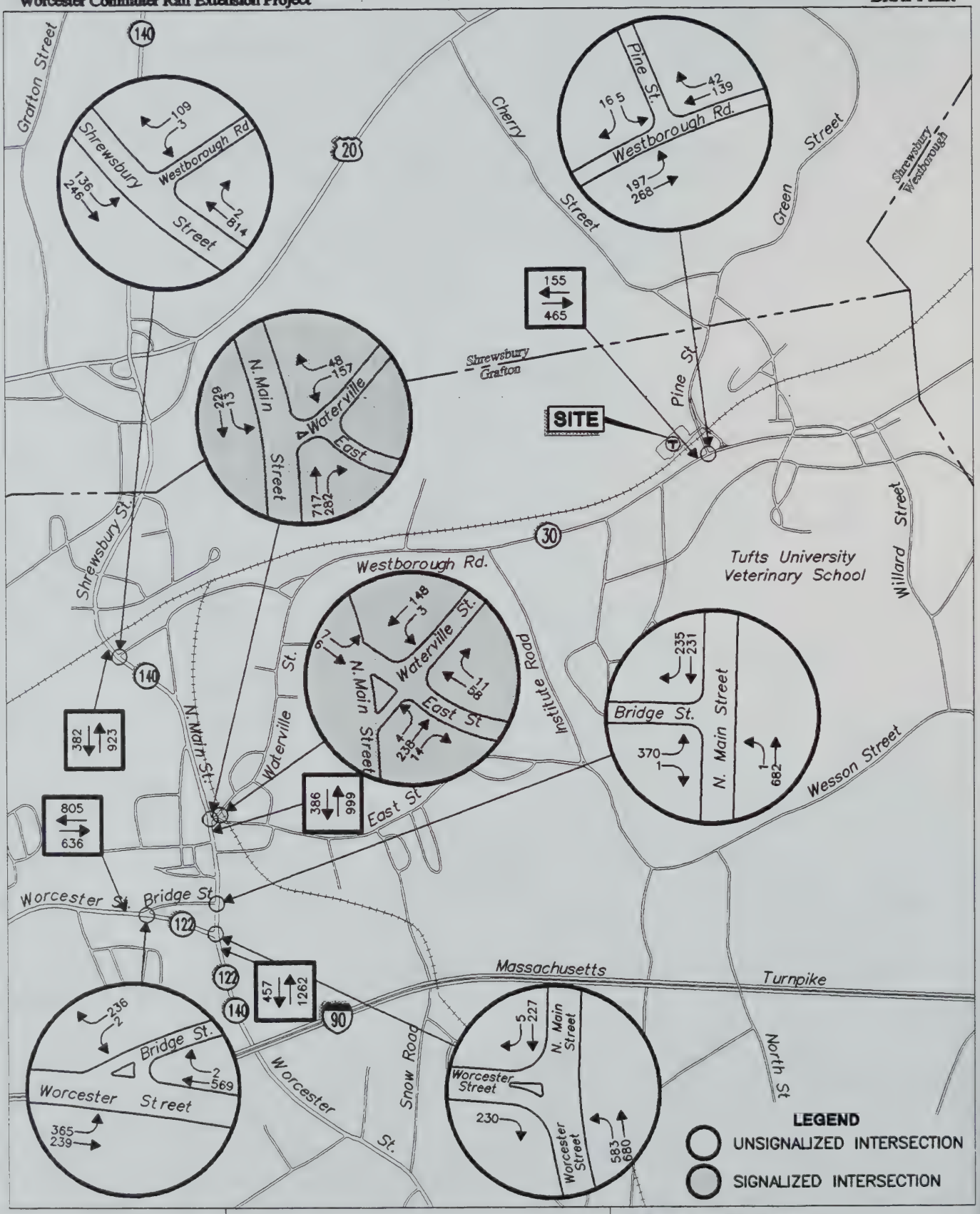
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

Distribution of Commuter Rail Station Traffic
1996 BUILD Grafton Only
GRAFTON STATION

FIGURE 1.5-15



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
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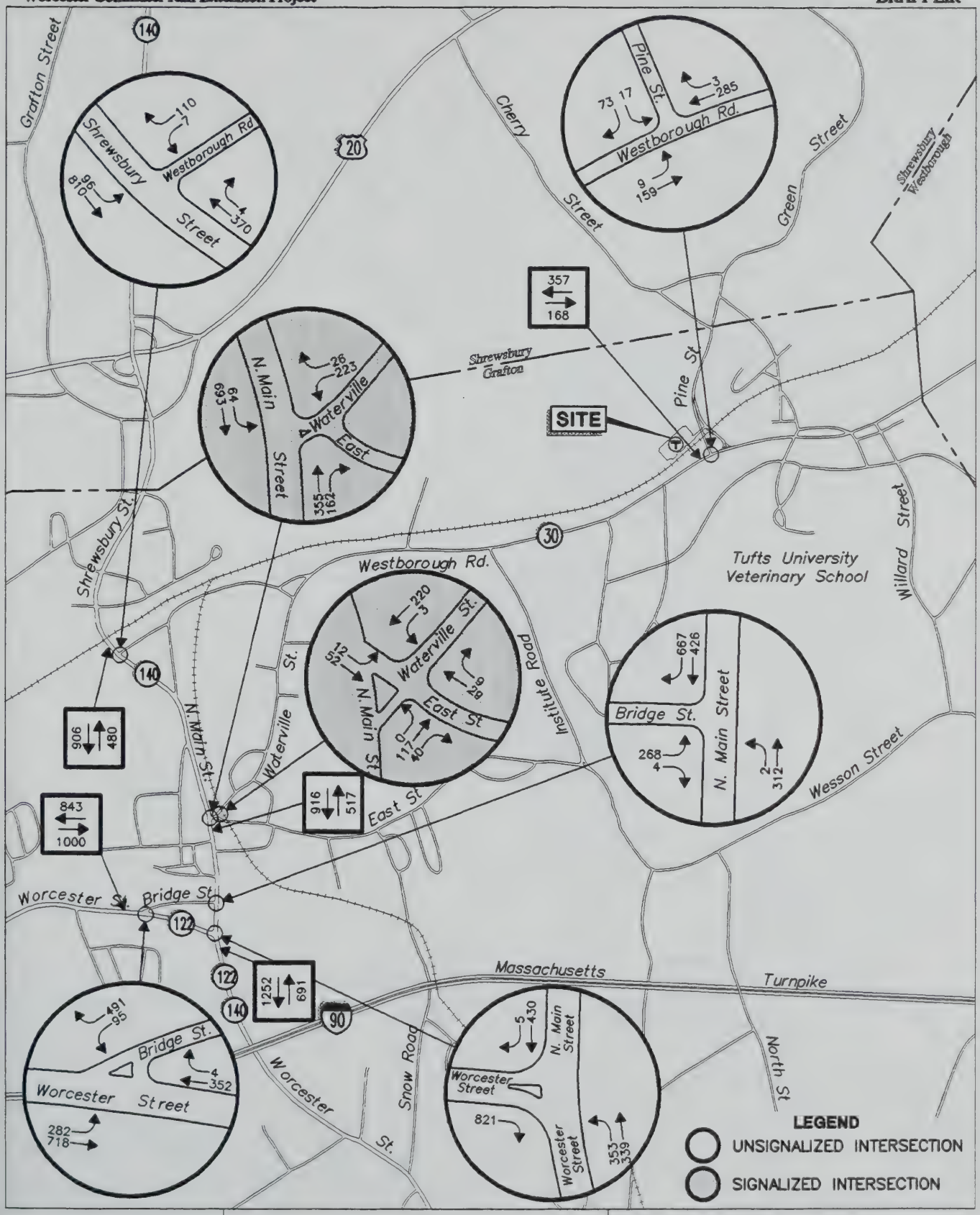
A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD Grafton Only
GRAFTON STATION

FIGURE 1.5-16



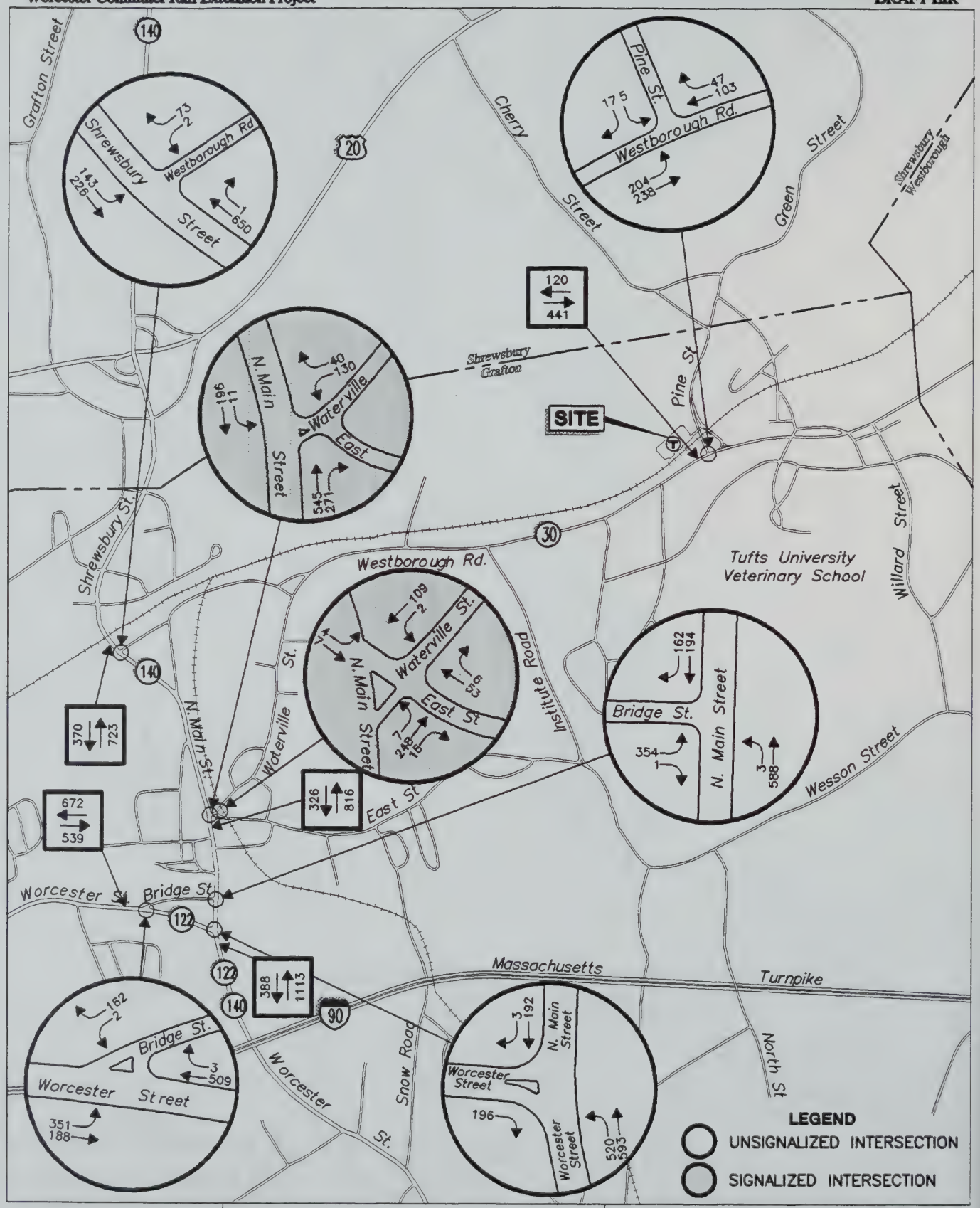
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1996 BUILD Grafton Only
GRAFTON STATION

FIGURE 1.5-17



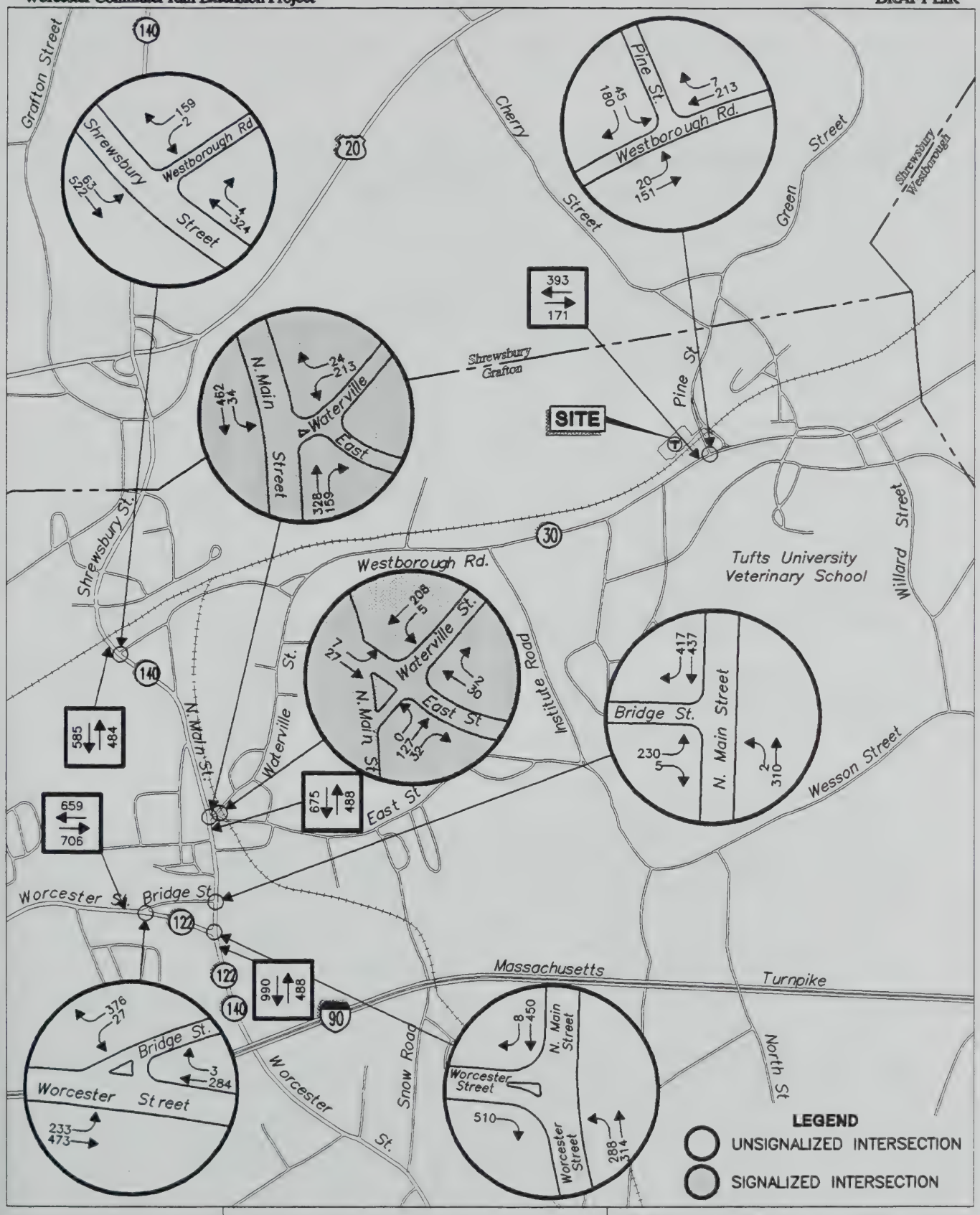
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
1996 BUILD Grafton Only
GRAFTON STATION

FIGURE 1.5-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
1996 BUILD Grafton Only
GRAFTON STATION

FIGURE 1.5-19

Signalized Intersections

As the previously noted under 1996 Conditions, a new traffic signal will be in operation at the intersection of North Main/Waterville/East Streets. Results for the A.M. and P.M. peak roadway hours analysis are listed in Table 1.5-14.

Table 1.5-14 1996 Peak Hour Signalized Intersection Level of Service (Grafton Station Only)

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
North Main/Waterville/East Streets	B(12.5)	B(15.9)	B(12.4)	C(16.6)
Eastbound, East Street	D(31.0)	C(25.0)	D(31.0)	C(25.0)
Westbound, Waterville Street	D(36.2)	C(28.2)	D(29.4)	D(32.1)
Northbound	B(9.5)	B(6.5)	B(10.4)	B(6.5)
Southbound	A(4.5)	C(18.5)	A(4.8)	C(18.5)

LOS (Average Vehicle Stopped Delay in Seconds)

The table shows the LOS rating as well as the average delay in seconds per vehicle. In 1996, under the "No Build" and "Build" conditions, all movements would operate at acceptable levels of service.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.5-15. The table shows LOS ratings as well as the reserve capacity, in vehicles, for each intersection movement. Three of the five intersections have one movement with a peak hour LOS "E" or "F". For "No Build," the left and right turns from Bridge Street onto North Main Street operate at LOS "F"; the "Build" condition is virtually the same. The left turn from Bridge Street onto Worcester Street operates at LOS "E" in the A.M. peak hour and LOS "F" in the P.M. peak hour under the "No Build" condition; the "Build" condition is virtually the same. The through movement southbound on Route 140 south of Bridge Street continuing onto Worcester Street (Route 122/140) operates at LOS "F" in both A.M. and P.M. peak hours for the "No Build" condition; the "Build" condition is virtually the same. Overall, the "Build" impacts on the unsignalized intersections are minimal.

Table 1.5-15 1996 Peak Hour Unsignalized Intersection Level of Service (Grafton Station Only)

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	B(320)	A(583)	C(237)	A(581)
LT and RT from Westborough	D(134)	C(236)	D(118)	C(237)
North Main and Bridge				
LT from NB North Main	A(688)	B(316)	A(685)	B(311)
LT and RT from Bridge	F(-186)	F(-126)	F(-220)	F(-129)
Worcester and Bridge				
LT from SB Worcester	C(255)	A(494)	C(230)	A(494)
LT from Bridge	E(61)	F(-35)	E(53)	F(-35)
RT from Bridge	A(456)	B(387)	A(454)	B(380)
North Main and Worcester				
THRU from SB North Main	F(-103)	F(-343)	F(-109)	F(-351)
RT from SB North Main	C(297)	A(516)	C(291)	A(516)
Westborough and Pine				
LT from EB Westborough	A(930)	A(833)	A(741)	A(829)
LT and RT from Pine	A(591)	A(588)	A(538)	A(538)

LOS (Reserve Capacity - Vehicle)

Roadway Segments

The road segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.5-16 lists the results of this analysis for the A.M. and P.M. peak roadway hours.

All roadway segments will operate at acceptable levels of service for "No Build" and "Build" conditions for A.M. and P.M. peak hours with the exception of Route 122/140 South of Bridge Street which has a low level "E". The "Build" condition results in minor reductions in reserve capacity.

Table 1.5-16 1996 Peak Hour Road Segment Level of Service (Grafton Station Only)

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	C(1828)	C(1815)	D(1558)	C(1749)
Route 140 North of Westborough	D(1019)	D(1074)	E(992)	E(1063)
Route 140 South of Route 30	E(701)	E(734)	E(627)	E(720)
Route 122 West of Bridge	E(945)	E(636)	D(933)	E(630)
Route 122/140 South of Bridge Street	E(452)	E(382)	E(410)	E(375)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Peak Generator Hour Level of Service (Grafton Station Only)

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.5-17 for the 1996 "No Build" and "Build" conditions.

Table 1.5-17 1996 Peak Generator Hour Signalized Intersection Level of Service (Grafton Station Only)

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
North Main/Waterville/East Streets	B(7.9)	B(8.5)	B(8.0)	B(10.6)
Eastbound, East Street	C(17.5)	B(13.7)	C(17.5)	B(13.7)
Westbound, Waterville Street	C(16.8)	C(14.4)	C(17.7)	D(25.4)
Northbound	B(7.0)	B(6.1)	B(7.0)	B(6.2)
Southbound	A(4.4)	B(8.5)	A(4.4)	B(8.5)

LOS (Average Vehicle Stopped Delay in Seconds)

The table shows the LOS rating as well as the average delay in seconds per vehicle. In 1996, under the "No Build" and "Build" conditions, all movements would operate at acceptable levels of service.

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.5-18. The same movements at three of the five intersections which had LOS "E" or "F" under the peak hour analysis also have similar conditions under the peak generator hour. The left and right turns from Bridge Street onto North Main Street operate at LOS "F" for the A.M. and P.M. under "No Build" and "Build," but the reserve capacity is less negative than for the peak hour conditions. The left turn from Bridge Street onto Worcester Street will be LOS "E" in the A.M. and LOS "D" in the P.M. for both "No Build" and "Build". The southbound through movement on Route 140 south of Bridge Street will operate at LOS "F" under all conditions, but is only slightly worse for "Build" versus "No Build."

Table 1.5-18 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Grafton Station Only)

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	A(419)	A(662)	B(323)	A(655)
LT and RT from Westborough	C(249)	A(438)	C(233)	B(366)
North Main and Bridge				
LT from NB North Main	A(779)	A(459)	A(774)	A(426)
LT and RT from Bridge	F(-106)	F(-40)	F(-148)	F(-59)
Worcester and Bridge				
LT from SB Worcester	B(320)	A(607)	C(292)	A(604)
LT from Bridge	E(89)	D(108)	E(78)	D(107)
RT from Bridge	A(578)	A(592)	A(576)	A(564)
North Main and Worcester				
THRU from SB North Main	F(-24)	F(-242)	F(-31)	F(-275)
RT from SB North Main	B(350)	A(571)	B(342)	A(570)
Westborough and Pine				
LT from EB Westborough	A(981)	A(903)	A(766)	A(884)
LT and RT from Pine	A(611)	A(610)	A(584)	A(458)

LOS (Reserve Capacity - Vehicle)

Roadway Segments

The analysis for the 1996 peak generator hour for roadway segments is presented in Table 1.5-19.

Table 1.5-19 1996 Peak Generator Hour Road Segment Level of Service (Grafton Station Only)

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	C(1783)	C(2026)	D(1477)	C(1675)
Route 140 North of Westborough	D(1271)	D(1513)	D(1252)	D(1500)
Route 140 South of Route 30	E(982)	E(1162)	E(900)	E(1063)
Route 122 West of Bridge	D(1218)	E(1142)	D(1207)	E(1125)
Route 122/140 South of Bridge Street	E(692)	E(831)	E(656)	E(749)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

All roadway segments will operate at acceptable levels of service for "No Build" and "Build" conditions for A.M. and P.M. peak generator hours. The "Build" condition results in minor reductions in reserve capacity. With the exception of Route 30 west of Pine Street, reserve capacities are greater than for the peak hour values.

Year 1996 "Ten Percent of Traffic" Analysis (Grafton Station Only)

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.5-20 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

Table 1.5-20 1996 "Build" Condition - 10% Analysis (Grafton Station Only)

Intersection	Peak Hours	
	A.M.	P.M.
Shrewsbury and Westborough	6.6%	1.7%
North Main and Waterville	3.9%	0.9%
Waterville and East	10.9%	2.7%
North Main and Bridge	3.7%	1.1%
Worcester and Bridge	1.8%	0.3%
North Main and Worcester	1.7%	0.4%
Westborough and Pine	30.0%	9.6%
Roadway Segment		
Route 30 West of Pine	26.1%	8.0%
Route 140 North of Westborough	6.7%	1.7%
Route 140 South of Route 30	4.0%	1.0%
Route 122 West of Bridge	1.8%	0.3%
Route 122/140 South of Bridge Street	1.7%	0.4%

Site generated traffic as a percentage of total traffic

As shown in the table, two intersections and one roadway segment would receive 10 percent or more of their traffic from the proposed Grafton Station during roadway peak hours.

Year 2001 Conditions

Similar to the year 1996 conditions, an analysis was performed for the projected "No Build" and "Build" traffic conditions in the year 2001. Procedures and methodology for this analysis were the same as in the 1996 condition analysis. A detailed description of the analysis methodology is presented in Section 1.1 of the Appendix.

Year 2001 "No Build" Traffic Volumes

To determine the year 2001 "No Build" traffic volumes, the traffic volumes under the 1996 "No Build" conditions were adjusted based on anticipated growth in population and employment throughout the region. A growth rate of 1.5 percent per year was applied to the 1996 "No Build" traffic volumes. This positive rate is based on current employment projections which anticipate positive growth in 1996 of 1.4 percent and in 1997 of 1.6 percent. In addition to the 1.5 percent increase, a further positive

growth adjustment was made to allow for Phase I elements of the Tufts University and the Worcester Business Development Corporation biotech centers planned for the south side of Route 30 and west of Pine Street, respectively. Figures 1.5-20 and 1.5-21 show the projected 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak roadway hours. Figures 1.5-22 and 1.5-23 shows the projected year 2001 "No Build" traffic volumes for the A.M. and P.M. peak generator hours.

Year 2001 Trip Generation/Parking

Minor shifting is expected to occur in the town of origin of the patrons utilizing the proposed Grafton Station as presented in the 1996 conditions. The Massachusetts Central Transportation Planning Staff performed an analysis of projected ridership on the proposed commuter rail extension for the year 2001. By the year 2001, the proposed Grafton station is projected to attract 125 daily round trip commuters. Park'n'Ride patrons will be 115 in number, while 10 will be dropped off at the station.

These patrons are projected to reside in the Towns of Grafton, Shrewsbury, Sutton, Boylston and Northbridge. The number of patrons who originate from each town are shown in Table 1.5-21. The ridership has been adjusted to reflect peak period usage which is 94% of the total daily demand.

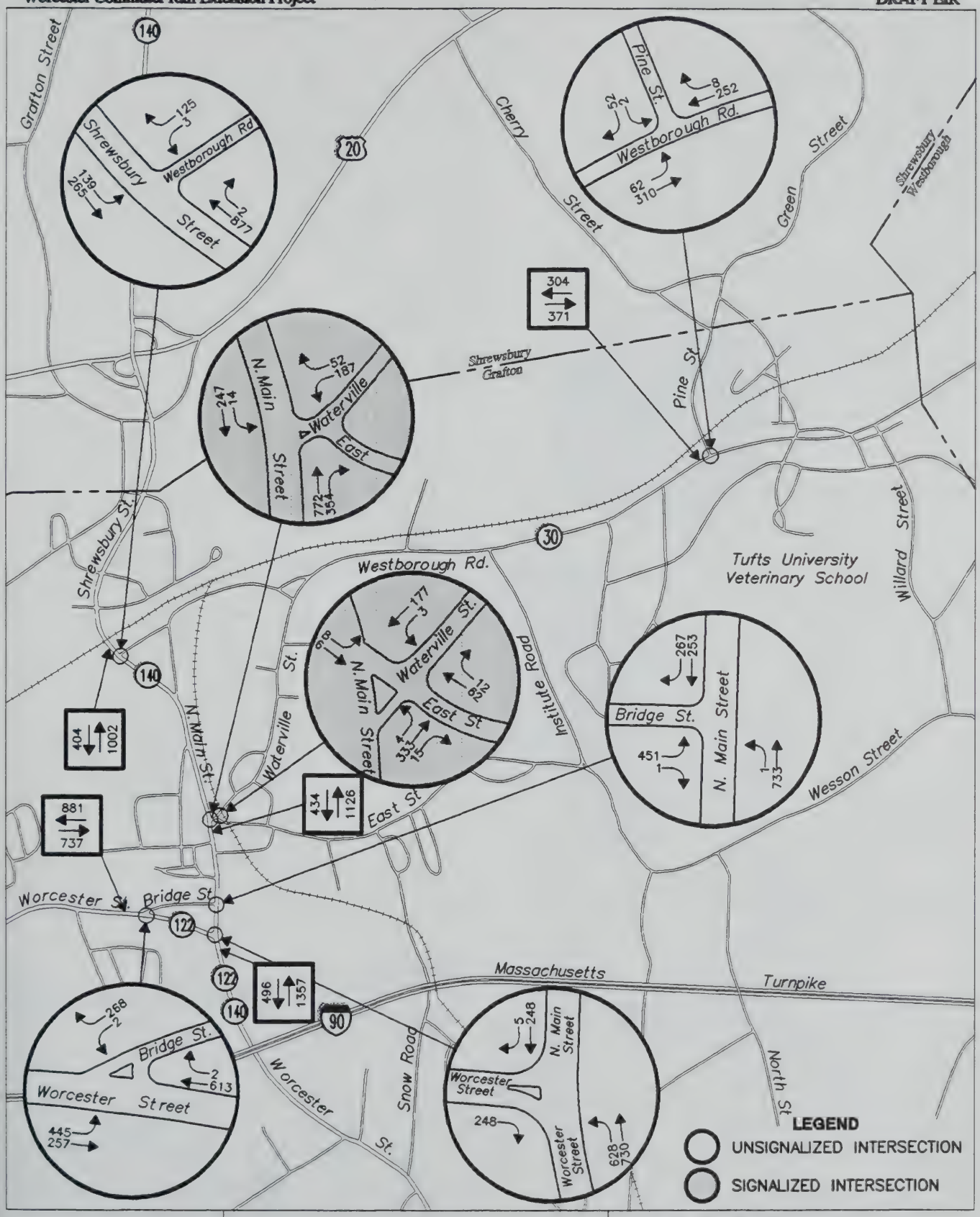
Table 1.5-21 Projected Patrons of Grafton Station Year 2001

Town	Riders*
Grafton	39
Shrewsbury	19
Sutton	16
Boylston	17
Northbridge	28
TOTAL	**119**

* *Adjusted for peak period demand*

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, of even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier of later. Similar trends are experienced during the P.M. peak return trip



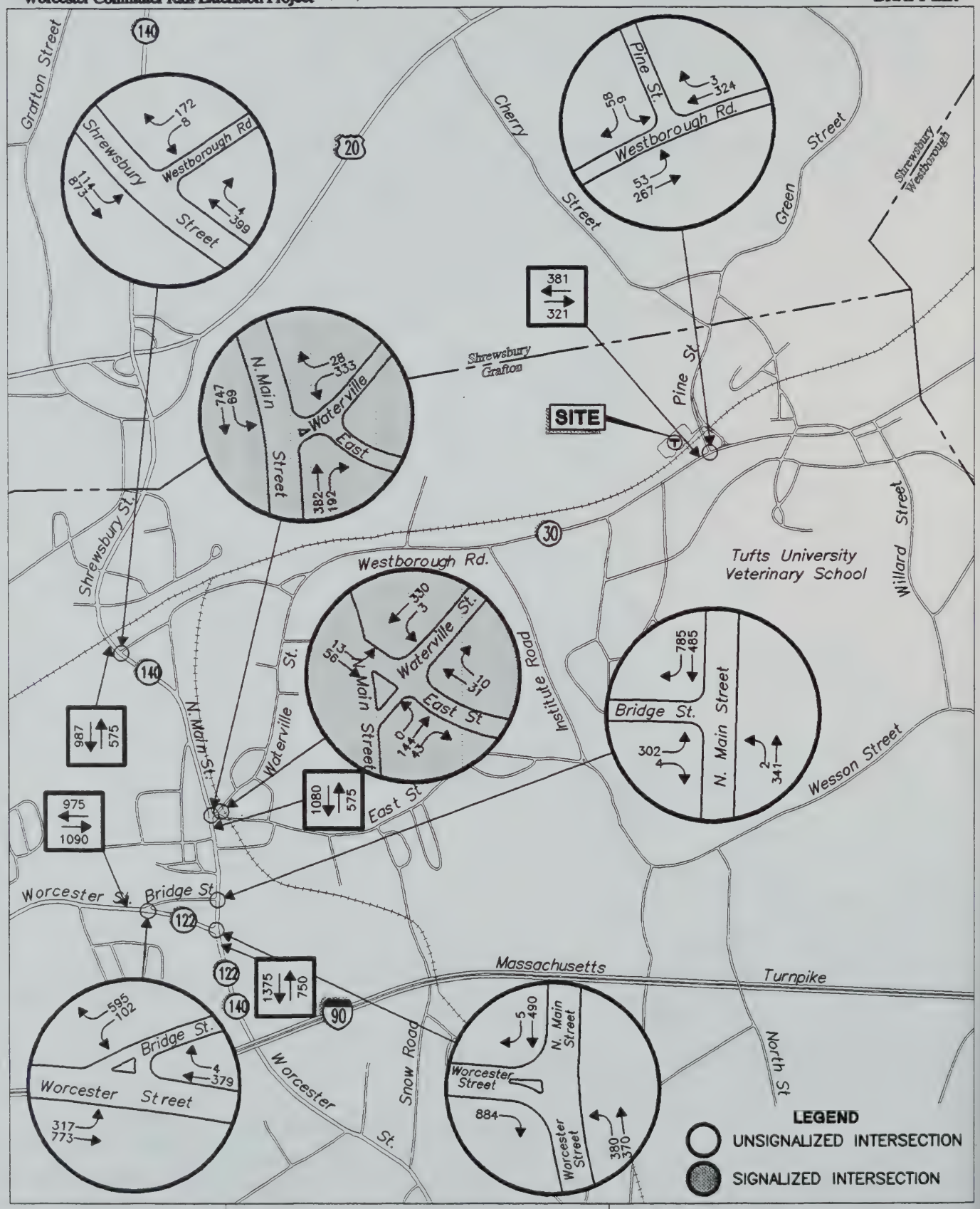
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 NO BUILD
GRAFTON STATION

FIGURE 1.5-20



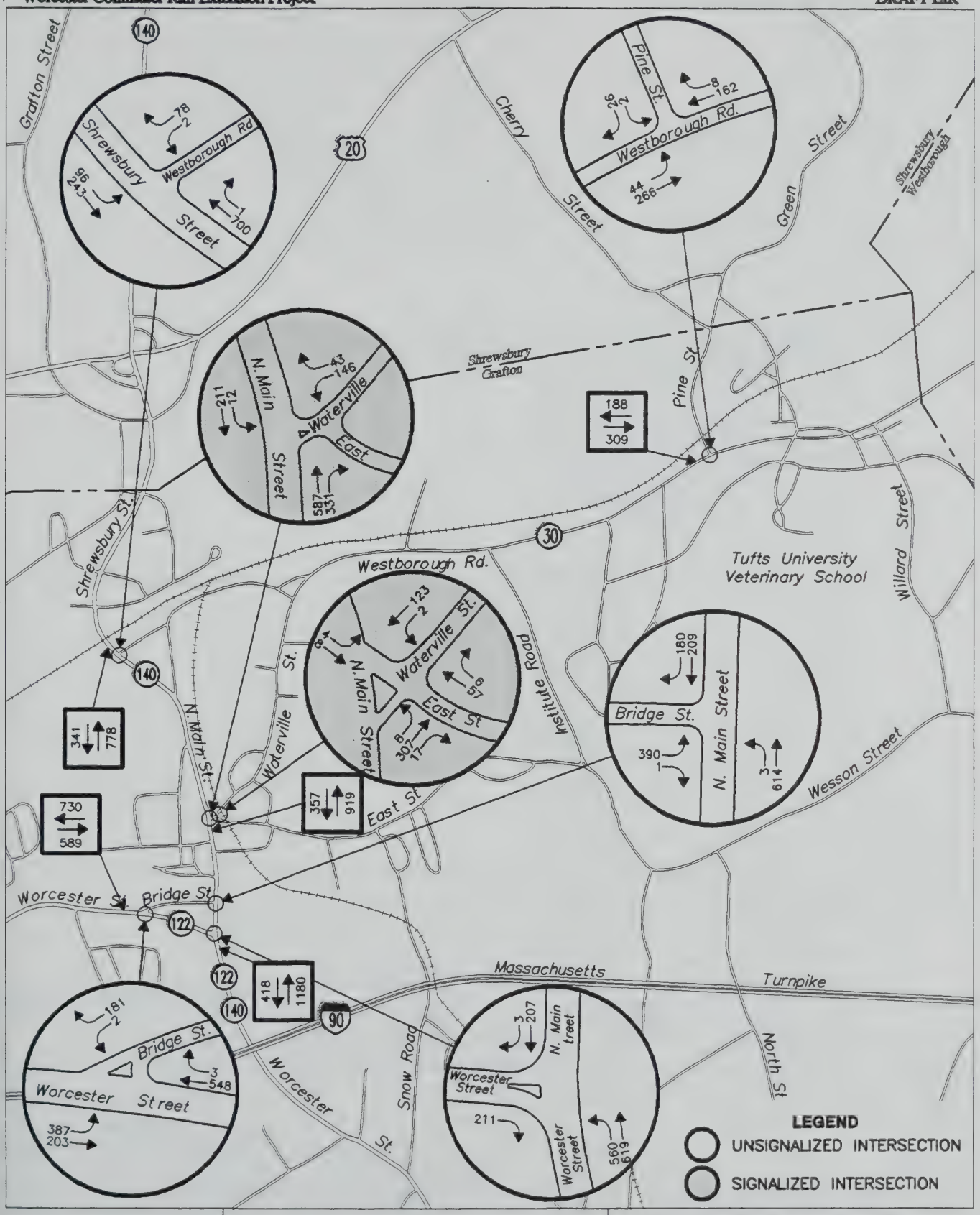
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
2001 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-21



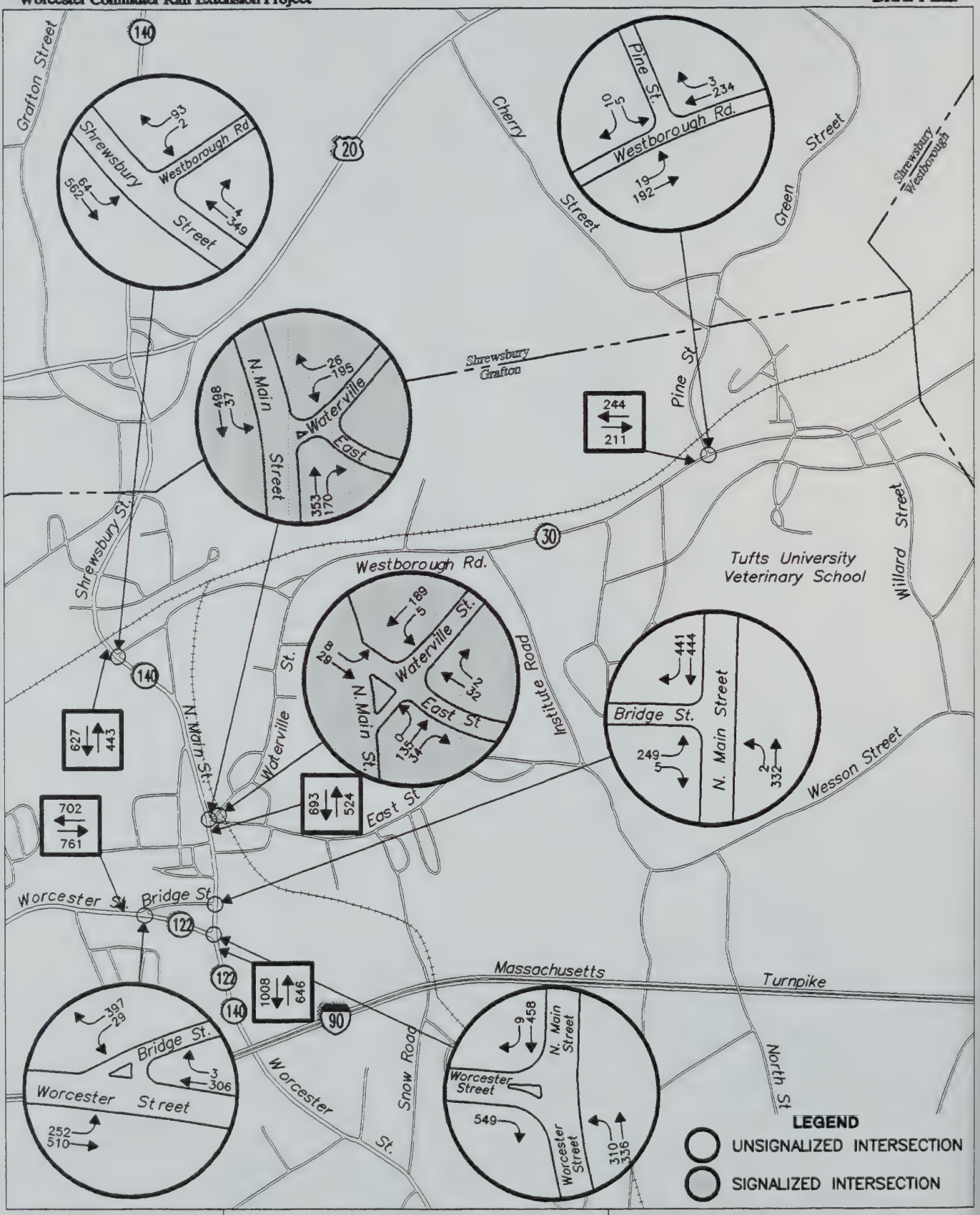
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
2001 NO BUILD
GRAFTON STATION

FIGURE 1.5-22



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
2001 NO BUILD
GRAFTON STATION

FIGURE 1.5-23

period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand the those that depart at other times.

The distribution of ridership per train is the same as under the 1996 conditions. Table 1.5-22 lists the typical distribution of ridership based on arrival/departure time in Boston.

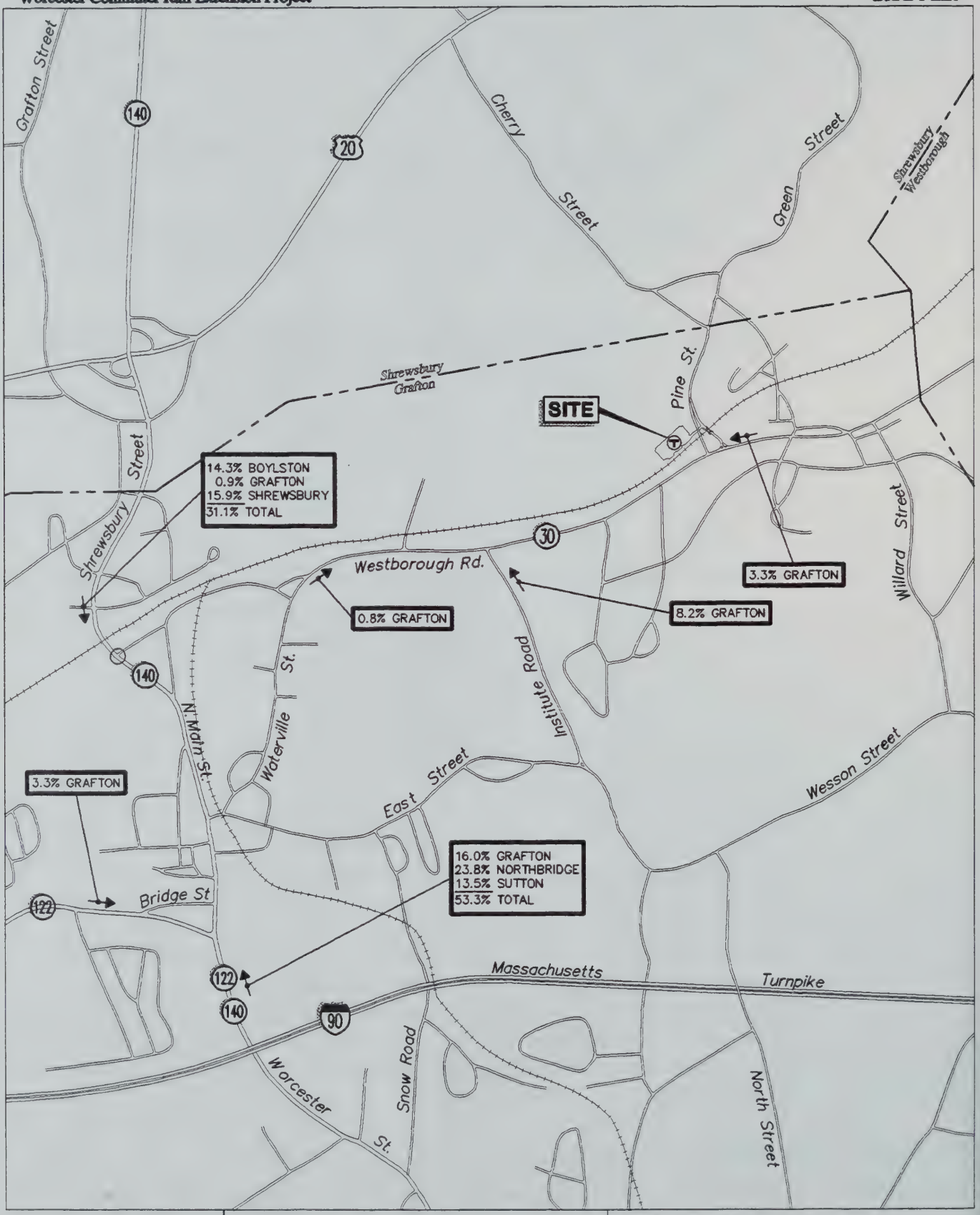
Table 1.5-22 MBTA Ridership Distribution - Grafton Station Year 2001

Inbound Train	Patrons
502A	23
504A	39
506A	39
510	18
TOTAL	**119**
Outbound Train	**Patrons**
515A	17
519	28
521	27
521A	41
523	6
TOTAL	**119**

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Grafton would utilize a variety of travel routes, depending on the location of their residence. Due to the minor shifts in town of origin of the patrons addressed previously, the percentage of site generated traffic on the study area roadways is slightly different than under the 1996 conditions. The same travel patterns are employed for year 2001 that were used in the 1996 analysis. Figure 1.5-24 shows the percentage of station related traffic utilizing the study area roadways for the 2001 "Build" condition.

Year 2001 "Build" Traffic Volumes

Figures 1.5-25 and 1.5-26 show the A.M. and P.M. peak roadway hour traffic volumes respectively. Figures 1.5-27 and 1.5-28 show the A.M. and P.M. peak generator hour volumes.



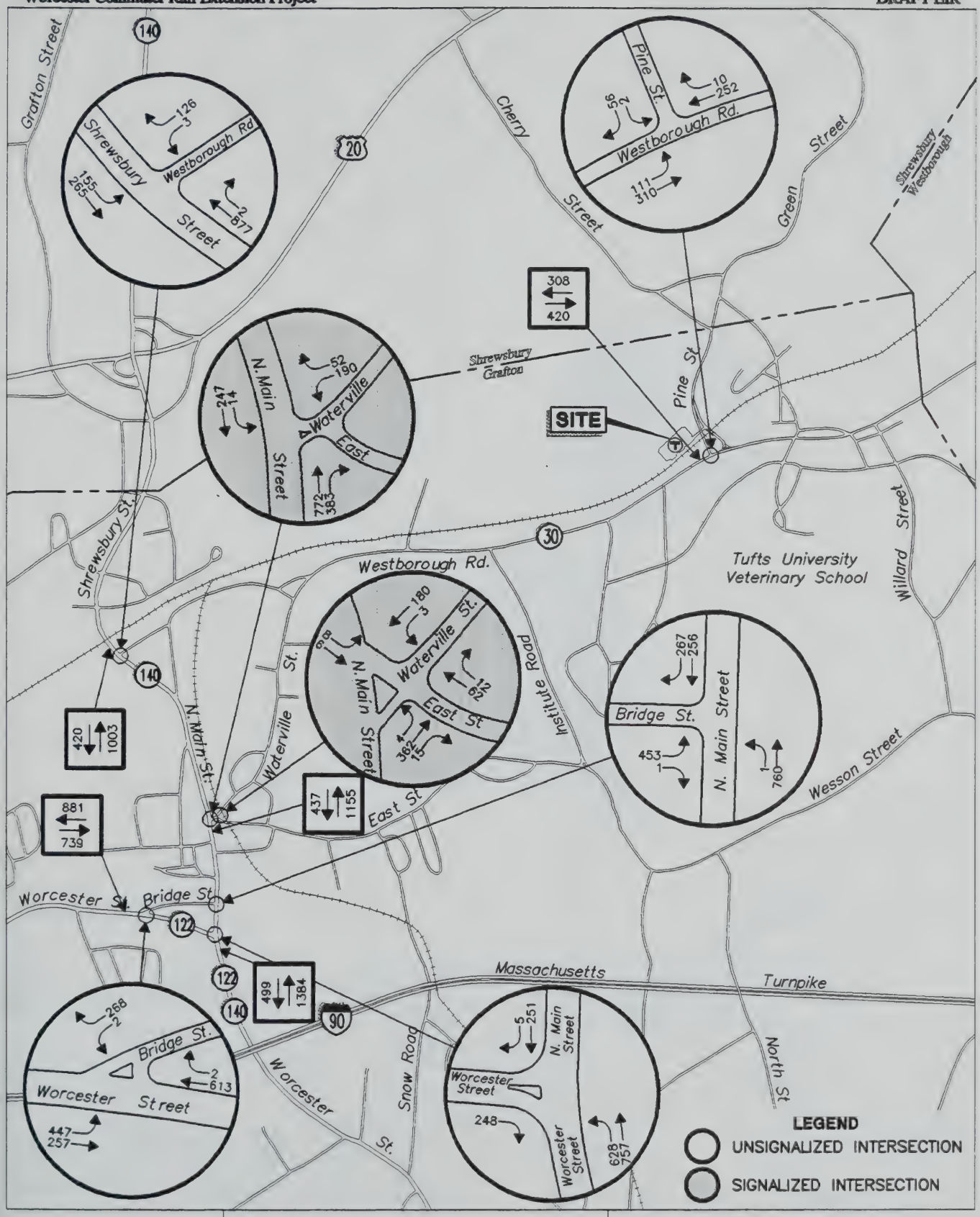
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-24



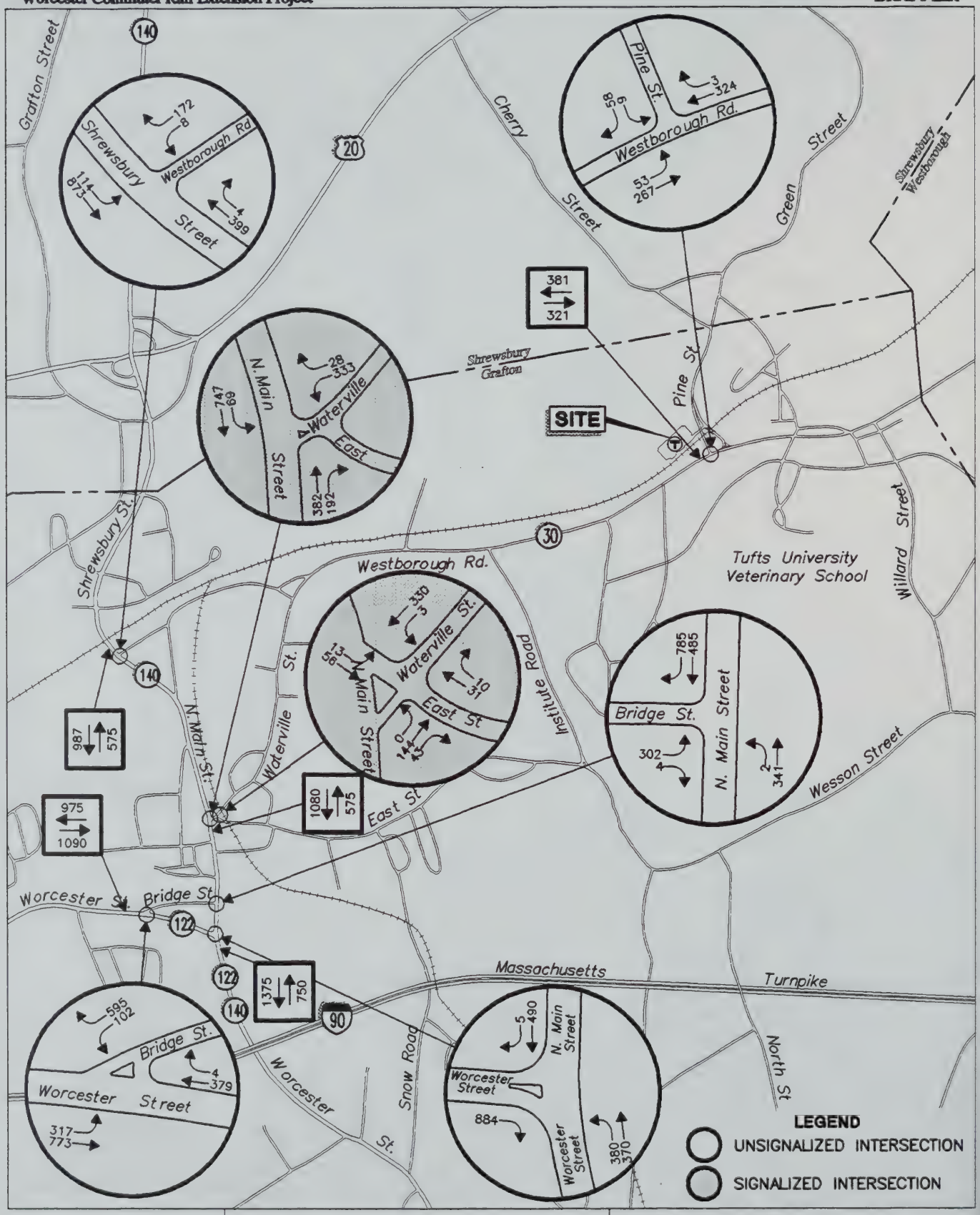
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-25

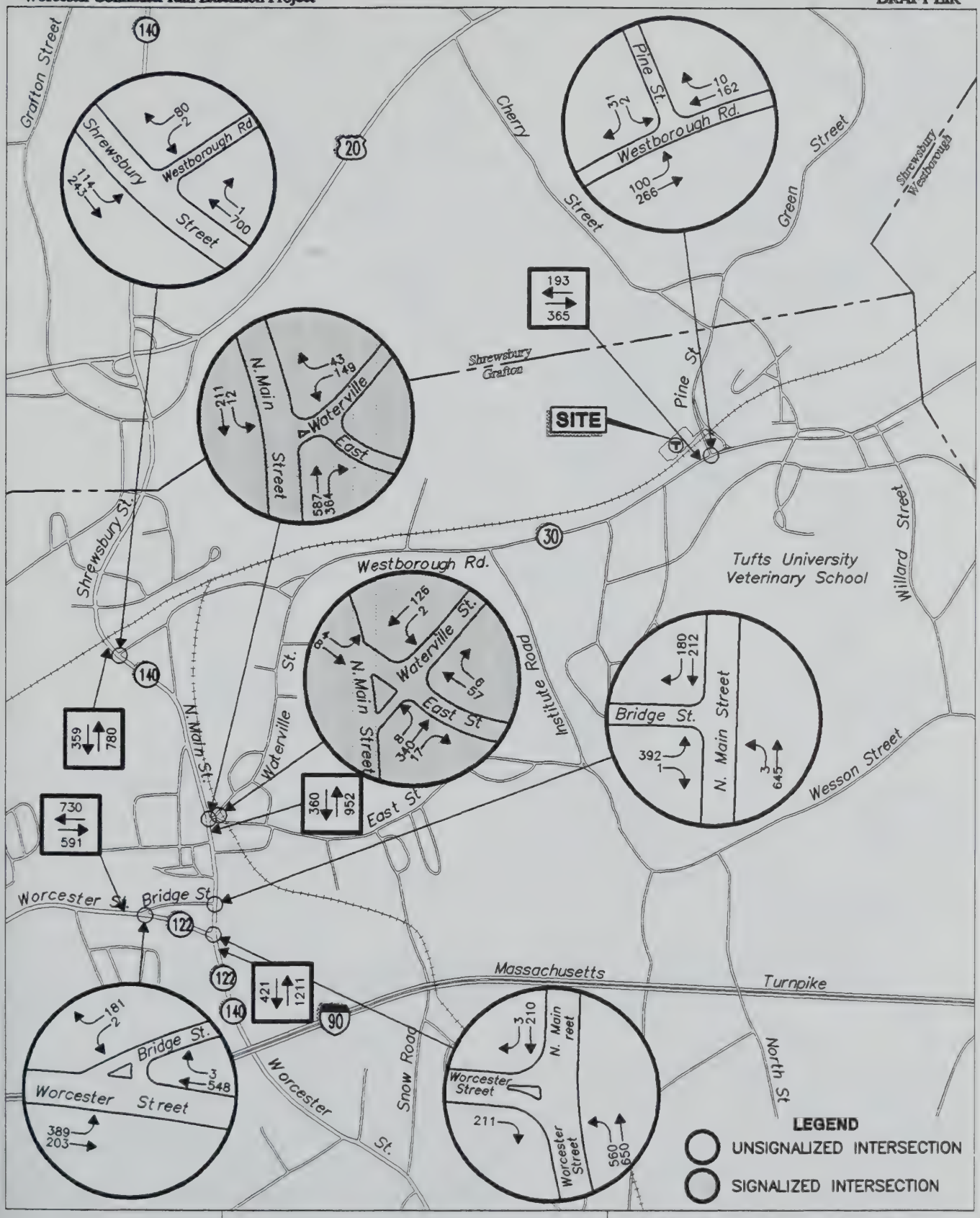


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
2001 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-26



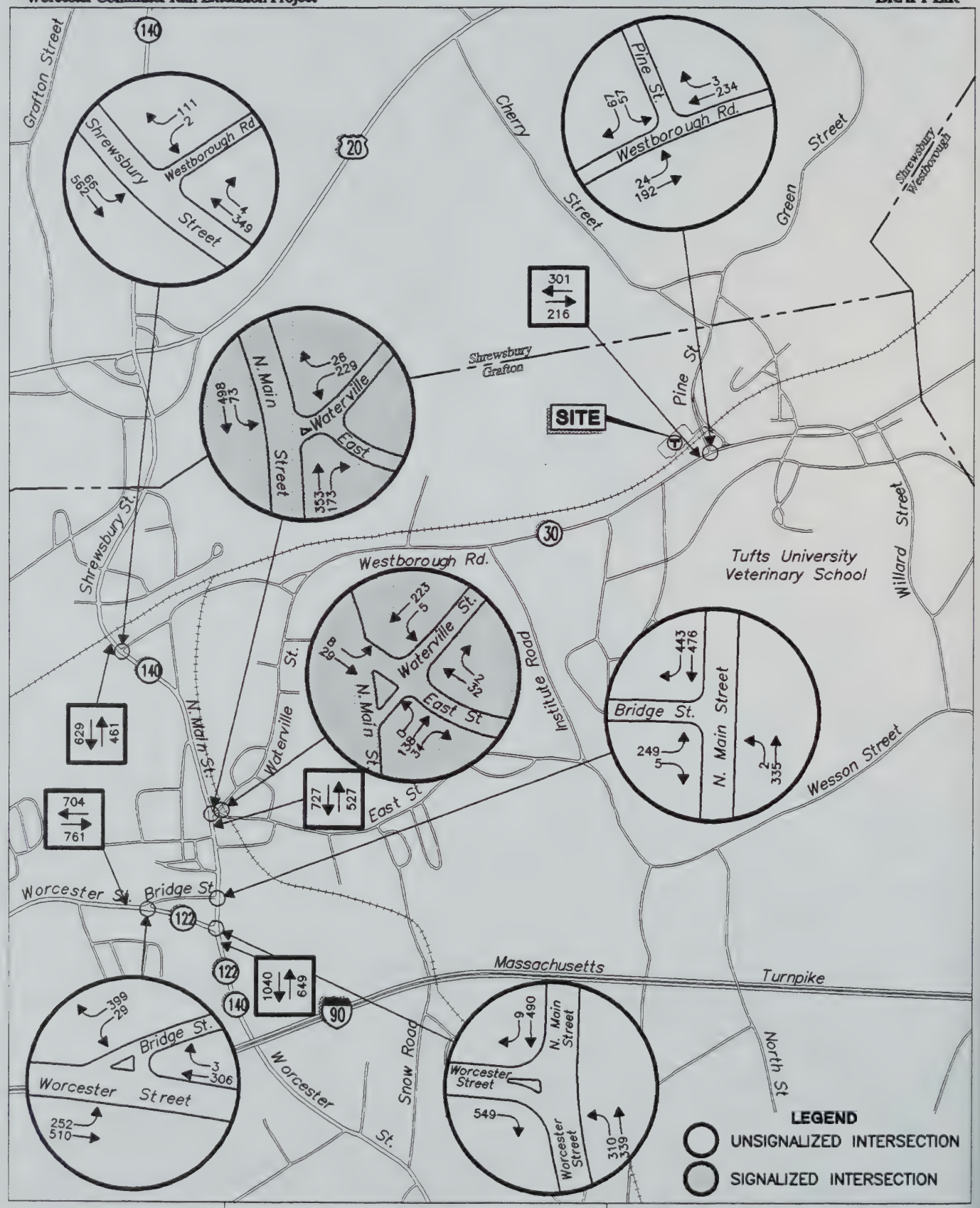
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±

0 1750

A.M. Peak Generator Hour
6:45 - 7:45 A.M.
2001 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1750'±
0 1750

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
2001 BUILD ALL STATIONS
GRAFTON STATION

FIGURE 1.5-28

Year 2001 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing and 1996 "No Build" conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. The traffic volumes are the only parameter in the analysis that changes from the 1996 conditions. Roadway geometrics, signal timings, etc. remain unchanged.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.5-23 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 2001 "No Build" and "Build" conditions. The eastbound movement on East Street has a LOS "E" for the A.M. peaks and LOS "F" for both "No Build" and "Build" in the P.M. peak hours. The number of vehicles involved is negligible and the condition results from increased traffic since 1996, but there is virtually no effect from station generated traffic. All other movements are acceptable and nearly identical for the "No Build" and "Build" conditions.

Table 1.5-23 2001 Peak Hour Signalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
North Main/Waterville/East Streets	C(15.9)	D(30.1)	C(16.1)	D(31.0)
Eastbound, East Street	E(54.5)	F(85.1)	E(54.5)	F(85.1)
Westbound, Waterville Street	D(35.5)	E(50.8)	D(37.1)	E(55.4)
Northbound	B(12.7)	B(9.0)	B(12.7)	B(9.0)
Southbound	B(5.4)	D(33.9)	B(5.4)	D(33.9)

LOS (Average Vehicle Stopped Delay in Seconds)

Unsignalized Intersections

Result of the A.M. and P.M. peak roadway hour analysis are listed in Table 1.5-24. The table shows LOS ratings as well as the reserve capacity, in vehicles, for each intersection movement. Four of the five intersections have at least one movement with a peak hour LOS "E" or "F". For "No Build", the left and right turns from Bridge Street onto North Main Street operate at LOS "F" in both the A.M. and P.M. peak hours. The "Build" condition is virtually the same. The left turn from Bridge Street onto Worcester Street operates at LOS "E" in the A.M. peak hour and LOS "F" in the

P.M. peak hour for both the "No Build" and "Build" conditions. The negative reserve capacity is the same under "No Build" and "Build" showing no effect from station generated traffic. The through movement southbound on Route 140 south of Bridge Street continuing onto Worcester Street operates at LOS "F" in both the A.M. and P.M. peak hours under both "No Build" and "Build." Once again, the effect of station generated traffic is negligible. All other unsignalized intersection movements operate at acceptable levels of service and show little effect from traffic destined for the Grafton Station.

Table 1.5-24 2001 Peak Hour Unsignalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	C(202)	A(539)	D(185)	A(539)
LT and RT from Westborough	E(78)	D(164)	E(74)	D(162)
North Main and Bridge				
LT from NB North Main	A(643)	C(246)	A(640)	C(243)
LT and RT from Bridge	F(-327)	F(-197)	F(-336)	F(-199)
Worcester and Bridge				
LT from SB Worcester	D(117)	A(436)	D(115)	A(436)
LT from Bridge	E(22)	F(-59)	E(21)	F(-59)
RT from Bridge	B(388)	C(251)	B(388)	C(251)
North Main and Worcester				
THRU from SB North Main	F(-150)	F(-420)	F(-155)	F(-428)
RT from SB North Main	C(261)	A(487)	C(256)	A(486)
Westborough and Pine				
LT from EB Westborough	A(802)	A(751)	A(749)	A(750)
LT and RT from Pine	A(648)	B(504)	A(638)	A(510)

LOS (Reserve Capacity - Vehicle)

Roadway Segments

The road segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.5-25 lists the results of this analysis for the A.M. and P.M. peak roadway hours.

Table 1.5-25 2001 Peak Hour Road Segment Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	D(1792)	D(1784)	D(1688)	D(1753)
Route 140 North of Westborough	E(884)	E(924)	E(882)	E(920)
Route 140 South of Route 30	E(458)	E(499)	E(410)	E(490)
Route 122 West of Bridge	E(793)	E(435)	E(791)	E(435)
Route 122/140 South of Bridge Street	E(300)	E(182)	E(269)	E(172)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Most roadway segments will operate at acceptable levels of service for "No Build" and "Build" conditions for both A.M. and P.M. peak hours, with the exception of those segments with reserve capacity of less than 600 vehicles. The "Build" condition generally results in small reductions in reserve capacity.

Year 2001 Peak Generator Hour Level of Service

Signalized Intersections

An analysis was also performed for the peak station site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.5-26. The table shows LOS ratings as well as the average delay in seconds per vehicle. In year 2001 for the peak generator hour, all movements for all conditions provide an acceptable level of service. The peak generator hour has significantly less delays than does the peak hour.

Table 1.5-26 2001 Peak Generator Hour Signalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 140 and Route 30 and East	B(9.1)	B(10.0)	B(9.3)	B(10.9)
Eastbound, East Street	C(18.7)	B(13.8)	C(18.7)	C(17.5)
Westbound, Waterville Street	C(21.2)	C(20.1)	C(22.2)	C(18.2)
Northbound	B(8.0)	B(6.4)	B(8.1)	B(7.4)
Southbound	A(4.5)	B(9.6)	A(4.5)	B(10.9)

LOS (Average Vehicle Stopped Delay in Seconds)

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.5-27. The same movements which had LOS "E" or "F" under the peak hour analysis also have similar conditions under the peak generator hour. Although the left and right turns from Bridge Street onto North Main Street and the through movement southbound on Route 140 south of Bridge Street are at LOS "F", the condition is not quite as bad under the peak generator hour. The "Build" condition is only slightly worse then "No Build." The left turn from Bridge Street onto Worcester Street will operate at LOS "E" for all conditions, and is virtually the same for "No Build" and "Build."

Table 1.5-27 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Shrewsbury and Westborough				
LT from SB Shrewsbury	B(343)	A(632)	B(324)	A(630)
LT and RT from Westborough	C(208)	B(398)	C(205)	B(384)
North Main and Bridge				
LT from NB North Main	A(746)	A(409)	A(743)	B(392)
LT and RT from Bridge	F(-202)	F(-92)	F(-216)	F(-103)
Worcester and Bridge				
LT from SB Worcester	C(226)	A(564)	C(224)	A(564)
LT from Bridge	E(54)	E(83)	E(53)	E(83)
RT from Bridge	A(527)	A(522)	A(527)	A(520)
North Main and Worcester				
THRU from SB North Main	F(-66)	F(-306)	F(-73)	F(-338)
RT from SB North Main	B(317)	A(544)	B(310)	A(543)
Westborough and Pine				
LT from EB Westborough	A(910)	A(869)	A(850)	A(864)
LT and RT from Pine	A(741)	A(587)	A(730)	A(630)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.5-28 lists the results of this analysis for the A.M. and P.M. peak generator hours. All roadway segments will operate at acceptable levels of service for "No Build" and "Build" conditions for both A.M. and P.M. peak generator hours with the exception of one segment with a reserve capacity of less than 600 vehicles. Although the "Build" condition generally results in small reductions in reserve capacity, overall the reserve capacity is significantly better than for the peak hour condition.

Table 1.5-28 2001 Peak Generator Hour Road Segment Level of Service

Grafton	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 30 West of Pine	C(1783)	C(2016)	C(1684)	C(1886)
Route 140 North of Westborough	D(1183)	D(1434)	D(1188)	D(1428)
Route 140 South of Route 30	E(743)	E(1019)	E(690)	E(966)
Route 122 West of Bridge	E(1102)	E(1037)	E(1100)	E(1035)
Route 122/140 South of Bridge Street	E(554)	E(697)	E(518)	E(647)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.5-29 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. roadway hours.

Table 1.5-29 2001 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Shrewsbury and Westborough	1.2%	0.3%
North Main and Waterville	1.9%	0.5%
Waterville and East	4.3%	1.3%
North Main and Bridge	1.9%	0.5%
Worcester and Bridge	0.1%	0.0%
North Main and Worcester	1.6%	0.4%
Westborough and Pine	8.0%	2.0%
Roadway Segment		
Route 30 West of Pine	7.8%	2.0%
Route 140 North of Westborough	1.2%	0.3%
Route 140 South of Route 30	2.0%	0.6%
Route 122 West of Bridge	0.1%	0.0%
Route 122/140 South of Bridge Street	1.6%	0.4%

Site generated traffic as a percentage of total traffic

As shown in the table, there are no intersections or roadway segments that would receive 10 percent or more of their traffic from the proposed Grafton Station during roadway peak hours.

Summary of Findings

The basic findings of the traffic analysis were that most of the streets and intersections studied in Grafton are currently operating well. The exceptions are for turns from Waterville Street (Route 30) onto North Main Street (Route 140), turns from Bridge Street onto North Main Street, and for southbound through traffic on Route 140 south of Bridge Street. A new traffic signal will be installed at the Route 140/30 intersection in late 1994 or early 1995 to provide relief.

The addition of Grafton Station traffic will not result in any significant adverse effects. For both years 1995 and 2001, the "Build" condition will be nearly the same as the "No Build" condition in both the A.M. and P.M. peak hours for the signalized intersection, the unsignalized intersections and all roadway segments.

1.6 Westborough Station

Project Introduction

The proposed Westborough Commuter Rail station is to be constructed between Smith Valve Parkway and the existing Conrail tracks approximately one mile south of Route 9 and 1.7 miles west of Westborough Center. The vacant property is located just to the west of Otis Street. The station will primarily serve the communities or parts of the communities of Northborough, Shrewsbury, Upton, and Westborough.

This location was chosen based on its potential parking capacity, availability of vacant land, proximity to major access roadways, joint development potential and the minimal potential for environmental and neighborhood impacts.

The proposed station will consist of two 800 foot long low level platforms, with 45 foot long mini-high platforms for handicapped access, a pedestrian overpass, a drop-off area for Kiss'n'Ride patrons, adequate lighting for public safety and landscaping. A commuter parking lot of 300 spaces would be constructed in conjunction with the rail station. Access to the station parking would be provided via two driveways connecting to Smith Valve Parkway.

Study Area

The study area for assessment of traffic impacts at this station is focused on roadways which are anticipated to be used as the major access routes. These roadways include:

- Otis Street
- Smith Valve Parkway
- Route 9
- Fisher Street
- Mill Road
- Gleason Street
- Arch Street
- Glen Street

Also included in the study area are four underpass and one overpass structures within the Town of Westborough. The structures are on East Main Street, Water Street, Maynard Street, Fisher Street and Arch Street. If the structures require rehabilitation or reconstruction, the traffic impacts should be addressed.

Most of these roadways are maintained by the Town of Westborough. Route 9, the Boston-Worcester Turnpike, is a numbered route maintained by the State.

The intersection of Route 9 and Otis Street is controlled by traffic signals and represents the main entry point for commuters traveling from Northborough and Shrewsbury to the station site. For the most part, the remaining roadways studied are two lane facilities serving residential land uses. Otis Street, which provides direct access onto Smith Valve Parkway, serves industrial land uses primarily. Mill Road from W. Main Street will be the major access road for commuters from Upton and Westborough Center.

Data Collection

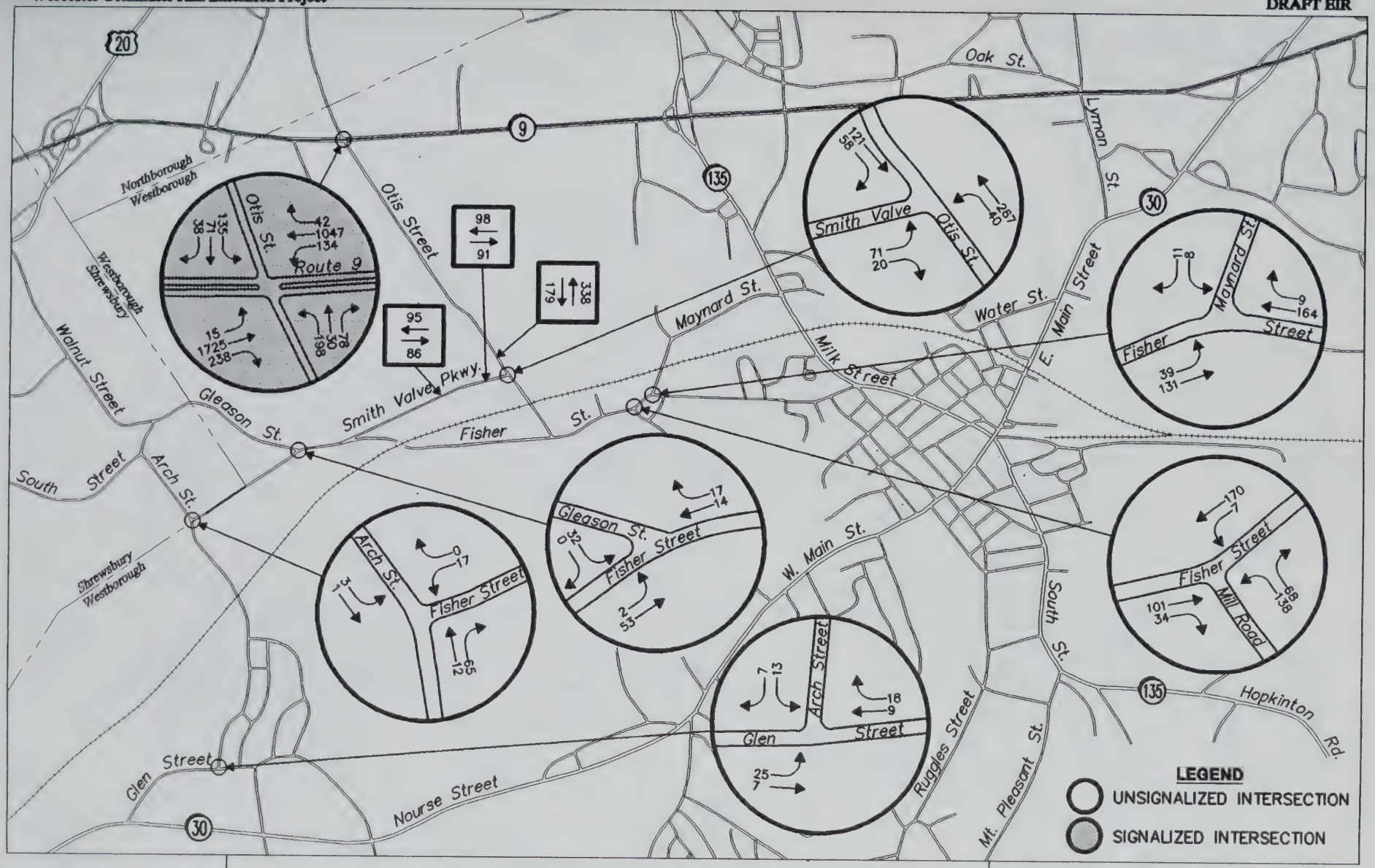
Traffic data collection including manual turning movement counts and machine road tube counts for this project were started in June of 1992 and completed in April of 1994. Data items necessary for analysis of operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing and timing, and geometric configuration of roadway links and intersections.

The vehicle turning movement counts used to obtain the traffic volumes used in the existing conditions analysis were made at the following intersections on the dates indicated in the following table:

	AM	PM
Route 9 with Otis Street	12-10-92	12-8-92
Otis Street with Smith Valve Parkway	9-11-92	9-10-92
Fisher Street with Mill Road	5-20-93	5-20-93
Fisher Street with Maynard Street	5-20-93	5-20-93
Fisher Street with Gleason Street	1-7-93	11-19-92
Fisher Street with Arch Street	4-28-94	4-28-94
Glen Street with Arch Street	4-27-94	4-27-94

Vehicle turning movements at these intersections were observed and recorded from 6:00 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the roadway peak hour volumes, and the volumes during the projected commuter rail station peak generator hours.

Vehicles were classified into two categories: cars, and trucks or buses. Volumes were recorded in 15 minute intervals to allow determination of the true peak hour, and calculation of peak hour factors. The 1992 peak hour traffic volumes are shown on Figures 1.6-1 and 1.6-2 for the A.M. and P.M. peak hours respectively. Since peak generator hours for the station's traffic may not coincide with standard peak hours, it is also necessary to analyze the A.M. and P.M. peak generator hours. The 1992 site

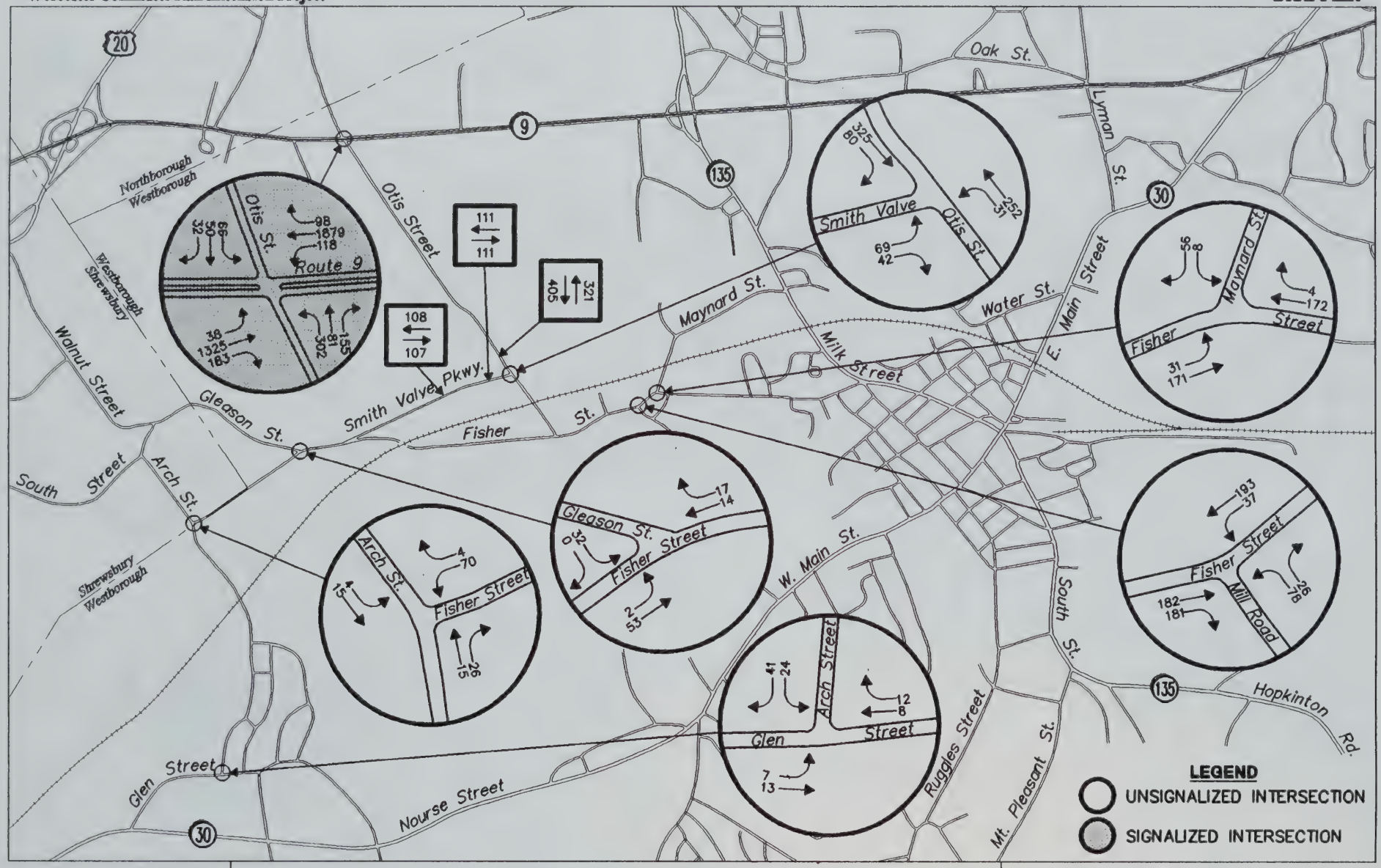


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

AM Peak Hour
7:30 - 8:30 A.M.
1992 Existing Conditions
WESTBOROUGH STATION

FIGURE 1.6-1



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

PM Peak Hour
4:45 - 5:45 P.M.
1992 Existing Conditions
WESTBOROUGH STATION

FIGURE 1.6-2

peak generator hours are shown on Figures 1.6-3 and 1.6-4 for the A.M. and P.M. peak hours respectively.

Traffic signal timing is required for analysis of signalized intersection operations. The existing traffic signals within the study area are traffic actuated. Phasing and timing of actuated signals were obtained from the Massachusetts Highway Department.

Intersection geometric configurations were determined through field observations. Geometric elements such as number and use of travel lanes, lane widths, and roadway grades are required for analysis of operational conditions and were observed in the field.

The field data sheets for the counts are available for review at the MBTA and MEPA Office.

Year 1992 Existing Conditions

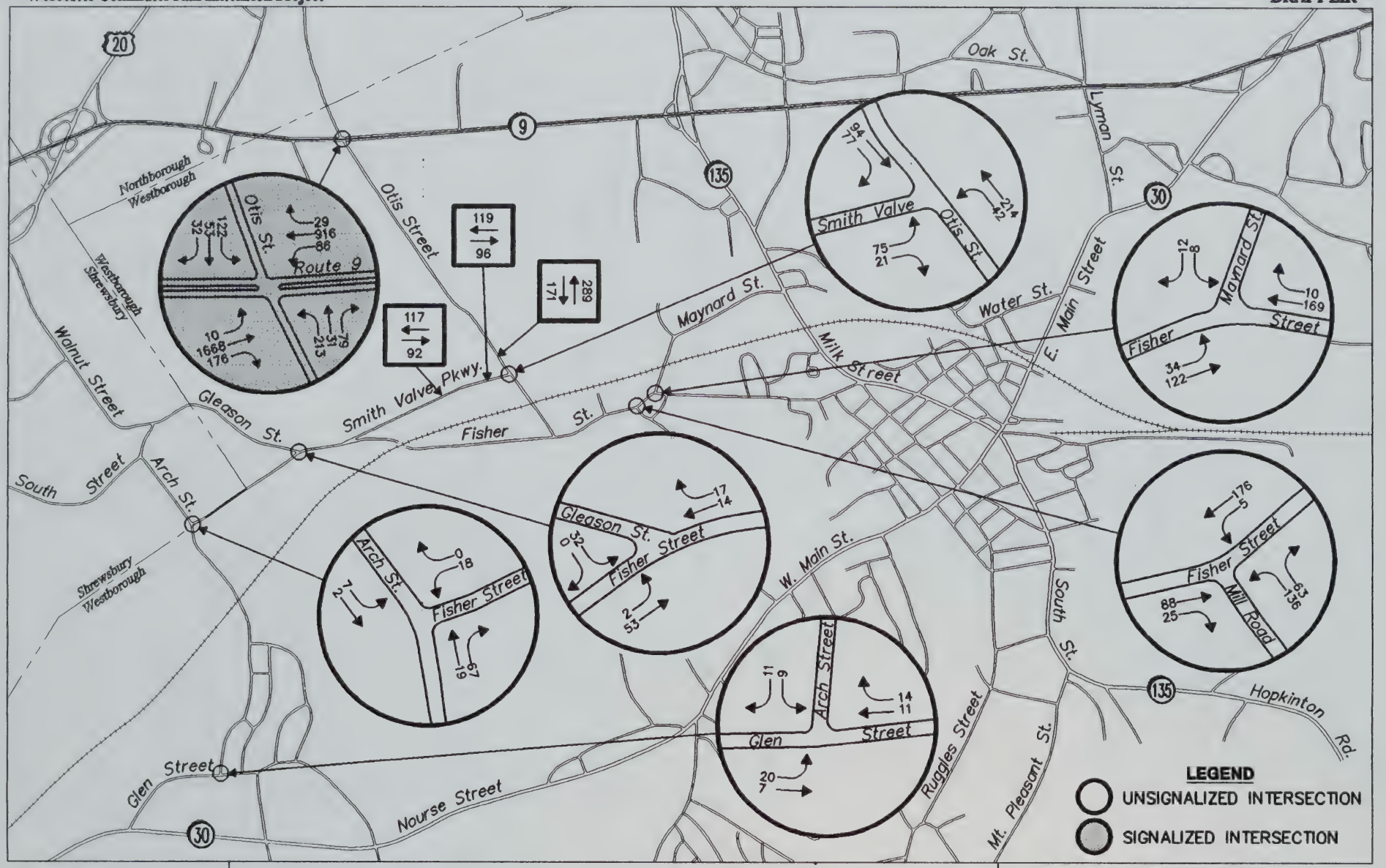
Signalized Intersections

The existing signalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209,* (HCM). The micro-computer software package "CINCH", developed by Central Transportation Planning Staff (CTPS) was used for the intersection analysis. The computerized outputs of "CINCH" can be found in a report available at the MBTA and MEPA. This program automates the analysis procedures of the HCM.

The analysis is based on various parameters such as intersection geometrics, traffic volumes and movements, traffic signal timing, vehicle mix, etc. The average length of time that a vehicle is sitting stationary at the intersection, known as average vehicle stopped delay, is determined and used to categorize the level of service (LOS) of the intersection. LOS ranges from a virtual free flowing condition "A", to congestion and high stopped delays "F". A detailed description of level of service is presented in Section 1.1 of this report. One signalized intersection was analyzed.

Route 9/Otis Street Intersection

Otis Street intersects Route 9 at a 90 degree angle forming a cross road intersection. Route 9 approaching Otis Street is a four lane divided highway. At Otis Street the Route 9 approaches include a right turn or left turn intersection lane. Otis Street is a two lane collector road approaching the Route 9 intersection. On the north side of Route 9 Otis Street has a left turn only lane and a through/right turn lane. On the



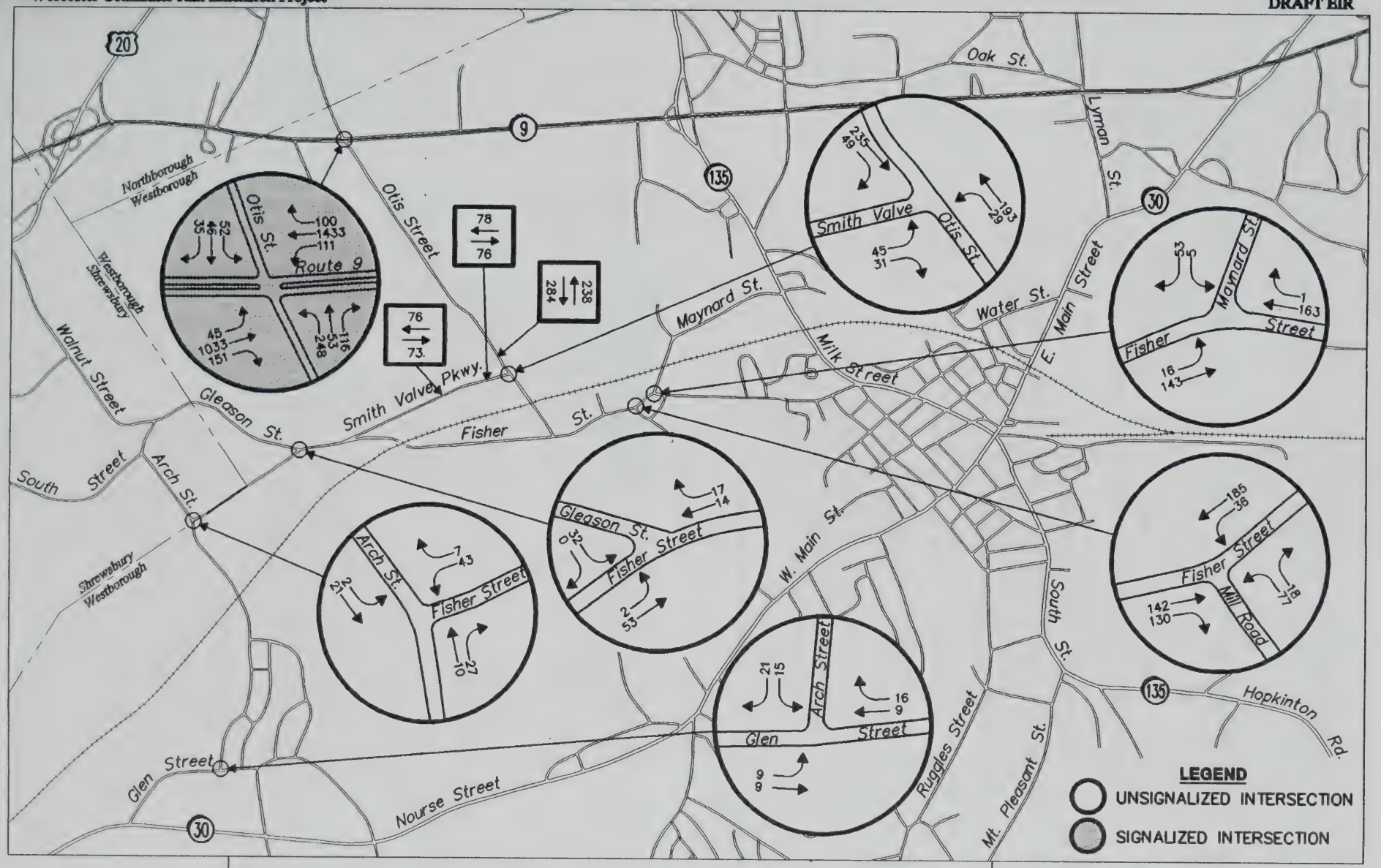
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

AM Peak Generator Hour
7:00 - 8:00 A.M.
1992 Existing Conditions
WESTBOROUGH STATION

FIGURE 1.6-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

PM Peak Generator Hour
5:45 - 6:45 P.M.
1992 Existing Conditions
WESTBOROUGH STATION

FIGURE 1.6-4

south side of Route 9 Otis Street traffic is controlled from entering this intersection by a traffic actuated signal.

The 1992 existing peak hour level of service ratings for the intersections analyzed in conjunction with the Westborough Station are found in Tables 1.6-1 and 1.6-2.

The intersection of Route 9 and Otis Street is the only signalized intersection within the study area. Currently the intersection has an acceptable overall A.M./P.M. peak hour level of service rating of "C". The southbound leg in the A.M. peak hour experiences a level of service rating of a high "E".

Table 1.6-1 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours. The peak generator hour for the commuter rail station is also shown and is the hour that usage of the rail station will be heaviest. The table shows the overall LOS rating for the intersection as well as each movement, and the average vehicle stopped delay, in seconds. Signalized intersections may be assigned an overall LOS rating as well as a rating on individual approaches.

As shown in the table, the intersection operates at an acceptable level of service in both the peak hours and the peak generator hours. The southbound approach operates at LOS "E" in the A.M. peak hour.

Table 1.6-1 1992 Existing Signalized Intersection Level of Service

Westborough	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis**	C(20.3)	C(19.4)	C(18.5)	C(16.3)
Eastbound	C(22.0)	B(13.7)	C(20.5)	B(13.0)
Westbound	B(10.5)	C(17.6)	B(9.4)	B(13.5)
Northbound	D(31.0)	D(39.9)	D(31.2)	D(31.9)
Southbound	E(41.6)	D(32.0)	D(31.5)	D(30.4)

LOS (Average Vehicle Stopped Delay in Seconds)

*** Optimized signal timings were used for analysis*

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The software program "CINCH" was used to perform the analysis. The computerized outputs of "CINCH" can be found in an uncirculated

report available at the MBTA and MEPA. As with the signalized intersections, A.M. and P.M. analysis was performed for both the intersection peak hour and the site peak generator hour.

As opposed to the signalized intersection results, level of service for unsignalized intersections are stated in terms of reserve capacity of a particular movement only. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. A detailed description of level of service is provided in Section 1.1 of this report.

Six unsignalized intersections were analyzed and include the following:

Otis Street/Smith Valve Parkway Intersection

Smith Valve Parkway intersects Otis Street at a 90 degree angle forming a "T" intersection. The intersection, as with the entire study area, is in the western part of Westborough, and typically south of Route 9. Otis Street is a two lane collector roadway, while Smith Valve Parkway is a two lane subcollector. The eastbound Smith Valve Parkway traffic is in a shared left and right turn lane and is controlled from accessing Otis Street by a stop sign.

Fisher Street/Mill Road Intersection

Mill Road intersects Fisher Street at 90 degrees forming a "T" intersection. Both roads are two lane collector roads. The northbound Mill Road traffic turning left or right is in a shared lane controlled from accessing Fisher Road by a stop sign.

Fisher Street/Maynard Street Intersection

Maynard Street intersects Fisher Street at an angle forming a "Y" intersection. Both roads are two lane roads. The southbound Maynard Street traffic turning left or right in a shared lane is controlled from entering Fisher Street by a stop sign.

Fisher Street/Gleason Street Intersection

Gleason Street intersects Fisher Street at an angle forming a "Y" intersection. Both roads are two lane roads. Gleason Street is classified as a subcollector. There is a traffic island separating the left and right turning southbound Gleason Street movements. The left turning or right turning traffic from Gleason Street is controlled from entering Fisher Street by stop signs.

Arch Street/Fisher Street Intersection

Fisher Street intersects Arch Street at approximately a 90 degree angle forming a "T" intersection. Both roads are two lane roads. Westbound Fisher Street traffic turning left or right in a shared lane is controlled from entering Arch Street by a stop sign.

Glen Street/Arch Street Intersection

Arch Street intersects Glen Street at approximately a 90 degree angle forming a "T" intersection. Both roads are two lane roads. Southbound Arch Street traffic turning left or right in a shared lane is controlled from entering Glen Street by a stop sign.

Table 1.6-2 1992 Existing Unsignalized Intersection Level of Service

Westborough	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1105)	A(1005)	A(1101)	A(1059)
LT and RT from Gleason	A(732)	A(710)	A(719)	A(738)
Otis and Smith Valve				
LT from NB Otis	A(909)	A(707)	A(915)	A(817)
LT and RT from Smith Valve	B(369)	C(265)	A(413)	A(414)
Fisher and Mill				
LT from WB Fisher	A(984)	A(734)	A(1010)	A(818)
LT and RT from Mill	A(414)	B(330)	A(431)	B(379)
Fisher and Maynard				
LT from EB Fisher	A(911)	A(918)	A(910)	A(945)
LT and RT from Maynard	A(628)	A(687)	A(638)	A(732)
Arch and Fisher				
LT from SB Arch	A(1109)	A(1149)	A(1095)	A(1155)
LT and RT from Fisher	(A883)	A(836)	A(865)	A(875)
Glen and Arch				
LT from EB Glen	A(1134)	A(1170)	A(1151)	A(1162)
LT and RT from Arch	A(931)	A(955)	A(973)	A(972)

LOS (Reserve Capacity-Vehicles)

Results of the A.M. and P.M. peak hour analyses are listed in Table 1.6-2. The table shows the LOS rating as well as the reserve capacity for each intersection movement. Unlike signalized intersections, only individual movements are assigned a level of service rating. The intersection cannot be assigned an overall rating. As shown in the table, all of the analyzed intersection movements operate at acceptable levels of service.

Results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.6-2. As shown in the Table, all of the unsignalized intersections operate at acceptable levels of service.

Roadway Segments

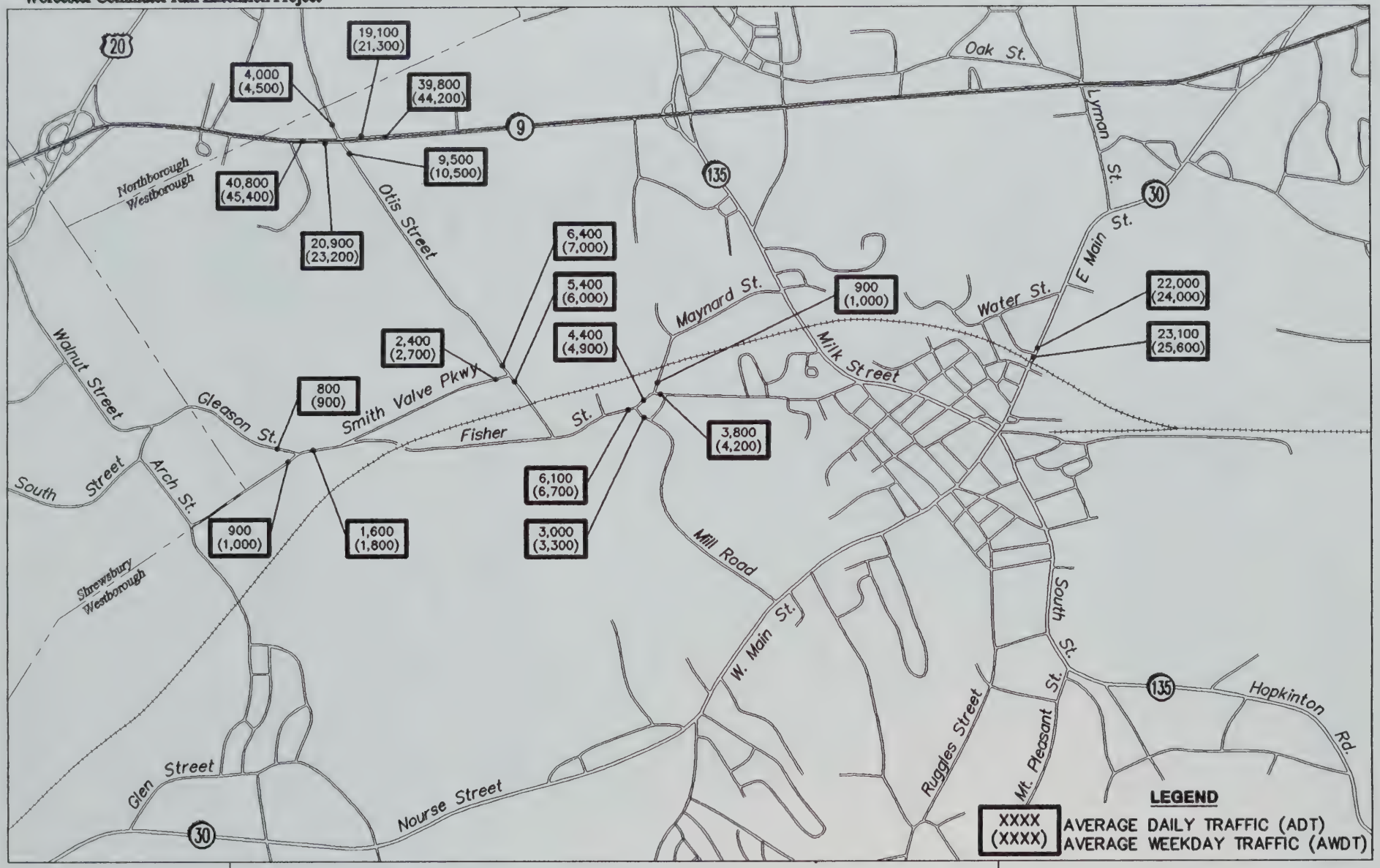
The average daily traffic (ADT) and average weekday traffic (AWDT) was collected for several streets. Figure 1.6-5 presents the 1992 ADT and AWDT volumes for several streets showing the relative 24 hour volumes of traffic that use these streets. Several roadway segments were analyzed for level of service. These segments were analyzed using the procedures set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The software program "Highway Capacity Software" (HCS) was used to perform the analysis. The computerized outputs from "HCS", can be found in a report available at the MBTA and MEPA. As with the intersection analysis, both the A.M. and P.M. peak roadway and site peak generator hours were analyzed. Table 1.6-3 lists the results of this analysis for the A.M. and P.M. peak roadway hours, and the A.M. and P.M. peak generator hours.

Table 1.6-3 1992 Existing Road Segment Level of Service

Westborough	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(1849)	C(1883)	C(2059)	C(2132)
Smith Valve West of Otis	B(2344)	B(2499)	B(2291)	B(2521)
Smith Valve West of Site	B(2353)	B(2498)	B(2283)	B(2527)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

As shown in the table, all of the roadway segments operate at acceptable levels of service.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

1992 Average Daily Traffic & 1992 Average Weekday Traffic WESTBOROUGH, MA

FIGURE 1.6-5

Safety Concerns and Accident History

The Westborough Police Department was contacted on June 27, 1994 to determine the existence and location of any safety concerns or high accident history intersections. Chief Parker did not believe that any of intersections or roadways within the study area currently experience a high frequency of accidents. He did express general concern about the effect of increased traffic within the area.

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned, except as noted below:

The Massachusetts Highway Department (MHD) is currently in the design phase of a project to improve the Route 9/Otis Street intersection. Currently, both Route 9 approaches consist of two (2) thru/general purpose lanes with one (1) exclusive left turn lane and one (1) exclusive right turn lane. The proposed project will lengthen the exclusive left turn lane for EB Route 9. Also, the existing exclusive right turn lanes on each Route 9 approach will be extended and modified to become additional thru/general purpose lanes. Therefore, both Route 9 approaches will consist of three (3) thru/general purpose lanes with one (1) exclusive left turn lane. It is anticipated that construction of this project will be completed by 1996. Therefore, the analysis of the Route 9/Otis Street intersection utilized the proposed geometry for both the "No Build" and the "Build" conditions.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments proximate to the study area.
- Increases in existing traffic volumes due to population growth and development proximate to, but outside of the study area.

Through discussions with the Town of Westborough, it was determined that no major new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of 1996 "No Build" condition traffic.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. The Massachusetts Highway Department compiles and publishes traffic volume data through a statewide traffic counting program. Five count sites for this data are located within the study area in Westborough. Based upon the data from these sites, the traffic volume growth rate was found to be extremely low, at an average annual growth rate of 0.3 percent. One location along Route 9 showed an average rate of negative 1.1 percent over the last 3 years.

This relatively low growth rate may be due to the economic downturn experienced throughout the region over the past years. Economic indicators point towards a recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

To account for this potential growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5 percent per year was applied to the 1992 Existing condition traffic volumes. Figure 1.6-6 shows the projected A.M. peak hour traffic volumes. Figure 1.6-7 shows the projected P.M. peak hour traffic volumes. Figure 1.6-8 shows the A.M. peak generator hour volumes. Figure 1.6-9 shows the P.M. peak generator hour volumes.

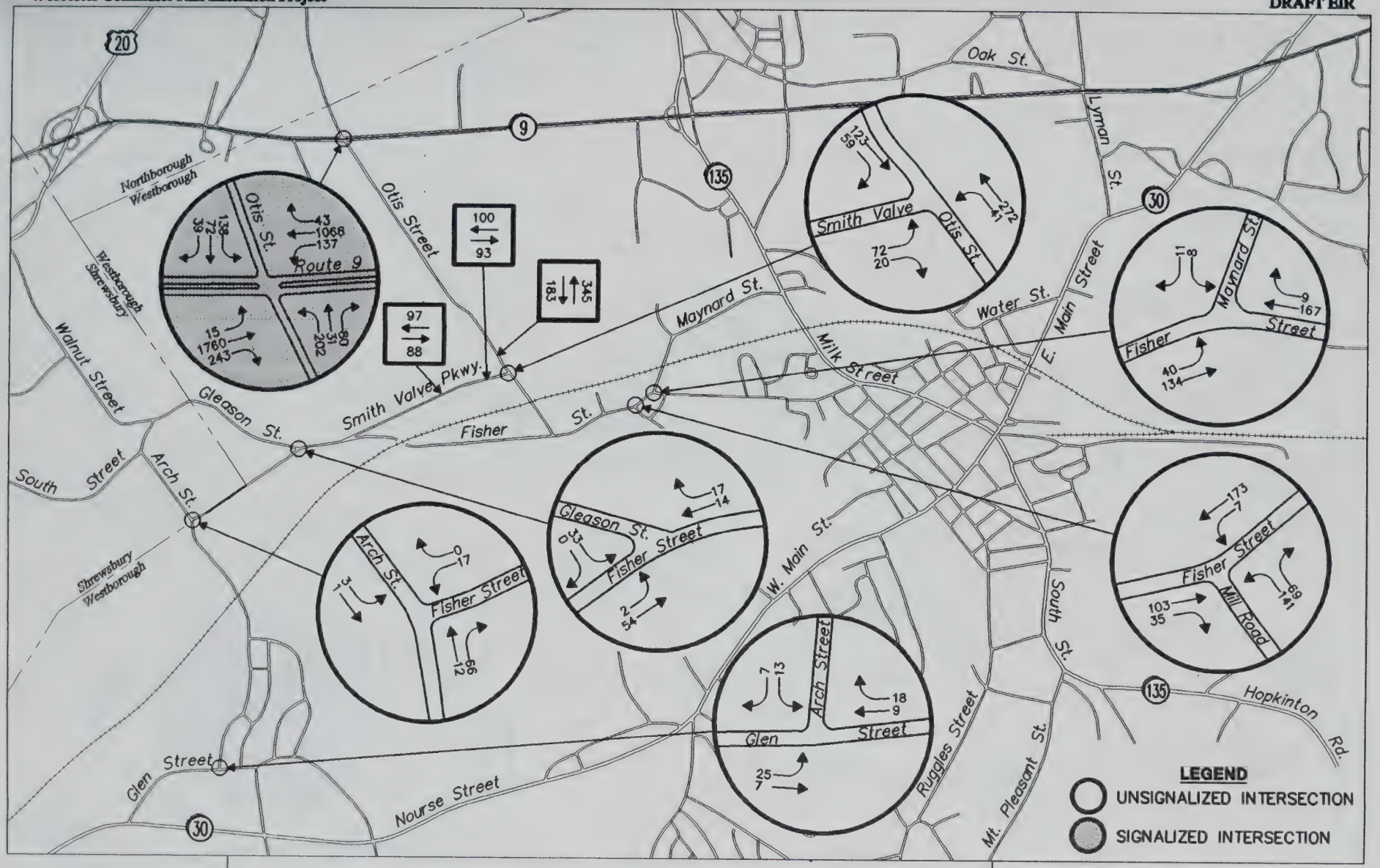
The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail to Worcester.

Year 1996 Trip Generation/Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 persons are expected to utilize the railroad for daily round trip commuting into Boston.

By the year 1996, the Westborough Station is projected to attract a total of 217 of these commuters. Because of the station's location, none of these patrons are anticipated to walk to the station. Seventeen are projected to be dropped off. The remaining patrons will drive to and park at the station. Based upon an average automobile occupancy rate of 1.12 people per car, the remaining 200 Park'n'Ride patrons would result in a parking demand of 179 spaces.

These patrons are projected to reside in the Towns of Westborough, Northbridge, Shrewsbury and Upton. The number of patrons who originate from each Town is shown in Table 1.6-4. The ridership has been adjusted to reflect peak period usage, which is 94% of the total daily demand.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

AM Peak Hour
7:30 - 8:30 A.M.
1996 NO BUILD
WESTBOROUGH STATION

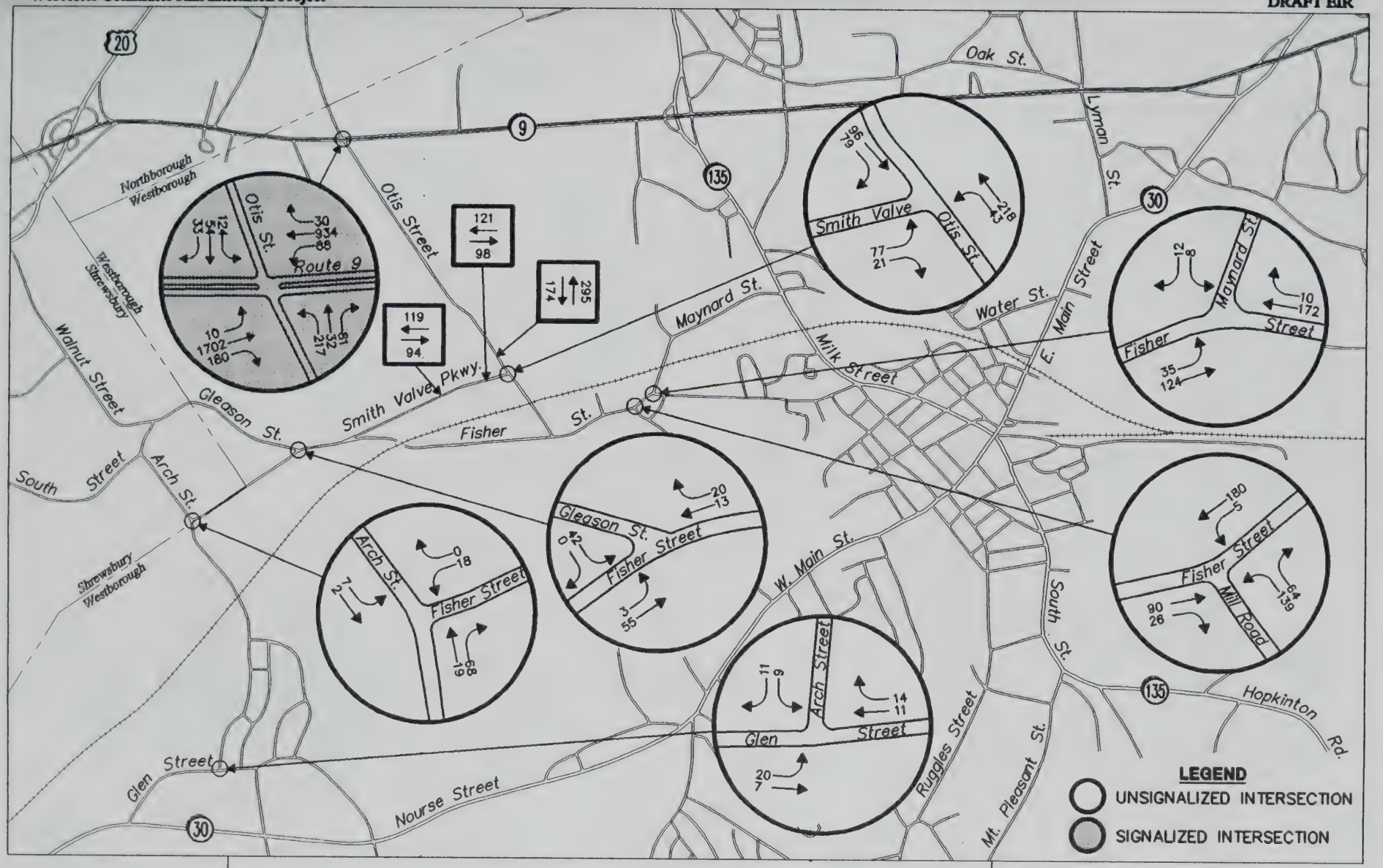
FIGURE 1.6-6

Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

PM Peak Hour
4:45 - 5:45 P.M.
1996 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-7



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

AM Peak Generator Hour
7:00 - 8:00 A.M.
1996 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-8

Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

PM Peak Generator Hour
5:45 - 6:45 P.M.
1996 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-9

Table 1.6-4 Projected Patrons of Westborough Station - Year 1996	
Town	**Riders***
Northborough	85
Shrewsbury	60
Upton	38
Westborough	21
TOTAL	**204**
* *Adjusted for peak period demand*	

These ridership levels are expected to occur shortly after completion of the Westborough Station, therefore, these projections were used in the analysis of the 1996 "Build" conditions.

Year 1996 Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand the those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.6-5 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.6-5 MBTA Ridership Distribution

Inbound Train	Patrons
502A	40
504A	66
506A	66
510	32
TOTAL	**204**
Outbound Train	**Patrons**
515A	29
519	47
521	47
521A	71
523	10
TOTAL	**204**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:30 - 8:30 A.M. and 4:45 - 5:45 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Westborough Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Westborough the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:45 to 5:45 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 7:00 to 8:00 A.M. and from 5:45 to 6:45 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside

in Westborough would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to major roadways leading from their town to the proposed station.

The primary access route from the Town of Northborough would be westbound Route 9 to Otis Street to Smith Valve Parkway. From the Town of Shrewsbury access would be Route 9 eastbound to Otis Street to Smith Valve Parkway. The primary access route from the Town of Upton would be South Street, Route 135, to West Main Street to Mill Road to Fisher Street to Otis Street to Smith Valve Parkway.

Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.6-10 shows the percentage of station related traffic utilizing the study are roadways for the 1996 "Build" condition.

Year 1996 "Build" Traffic Volumes

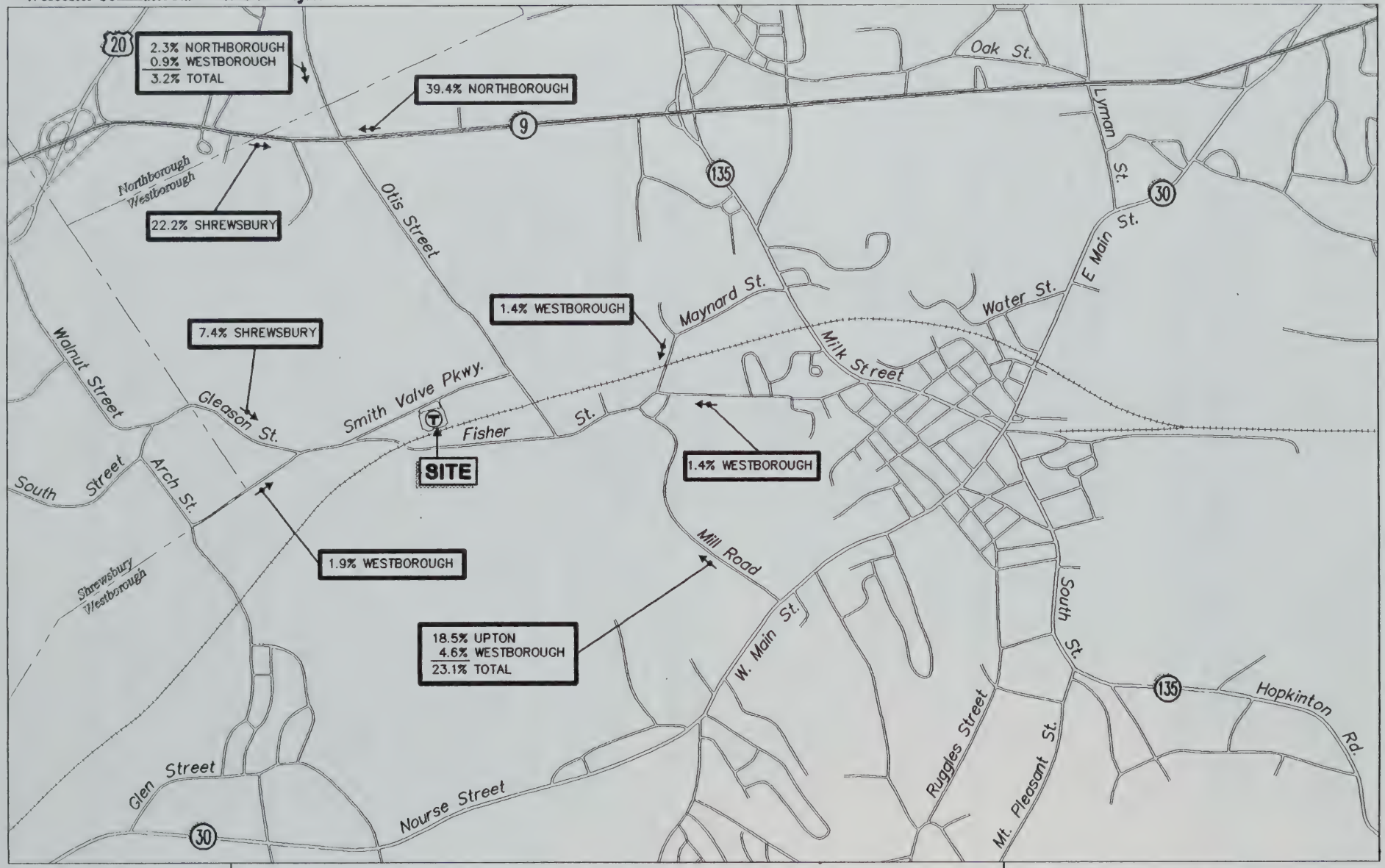
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Westborough rail station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Westborough. The existing vehicle trips would not be generated as completely new trips. Those vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways. This results in a "worst case" analysis. Figures 1.6-11 and 1.6-12 show the A.M. and P.M. peak hour traffic volumes, respectively. Figures 1.6-13 and 1.6-14 show the A.M. and P.M. peak generator hour volumes, respectively.

Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. Except for the Route 9/Otis Street intersection, the analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis change from the existing conditions. Roadway geometrics, etc. remain unchanged. As previously noted, MHD is currently designing modifications to the Route 9/Otis Street intersection. Since it is anticipated that the modifications will be in place by 1996, the analysis of the Route 9/Otis Street incorporated the proposed modifications. Signal timings were optimized for both the "No Build" and "Build"

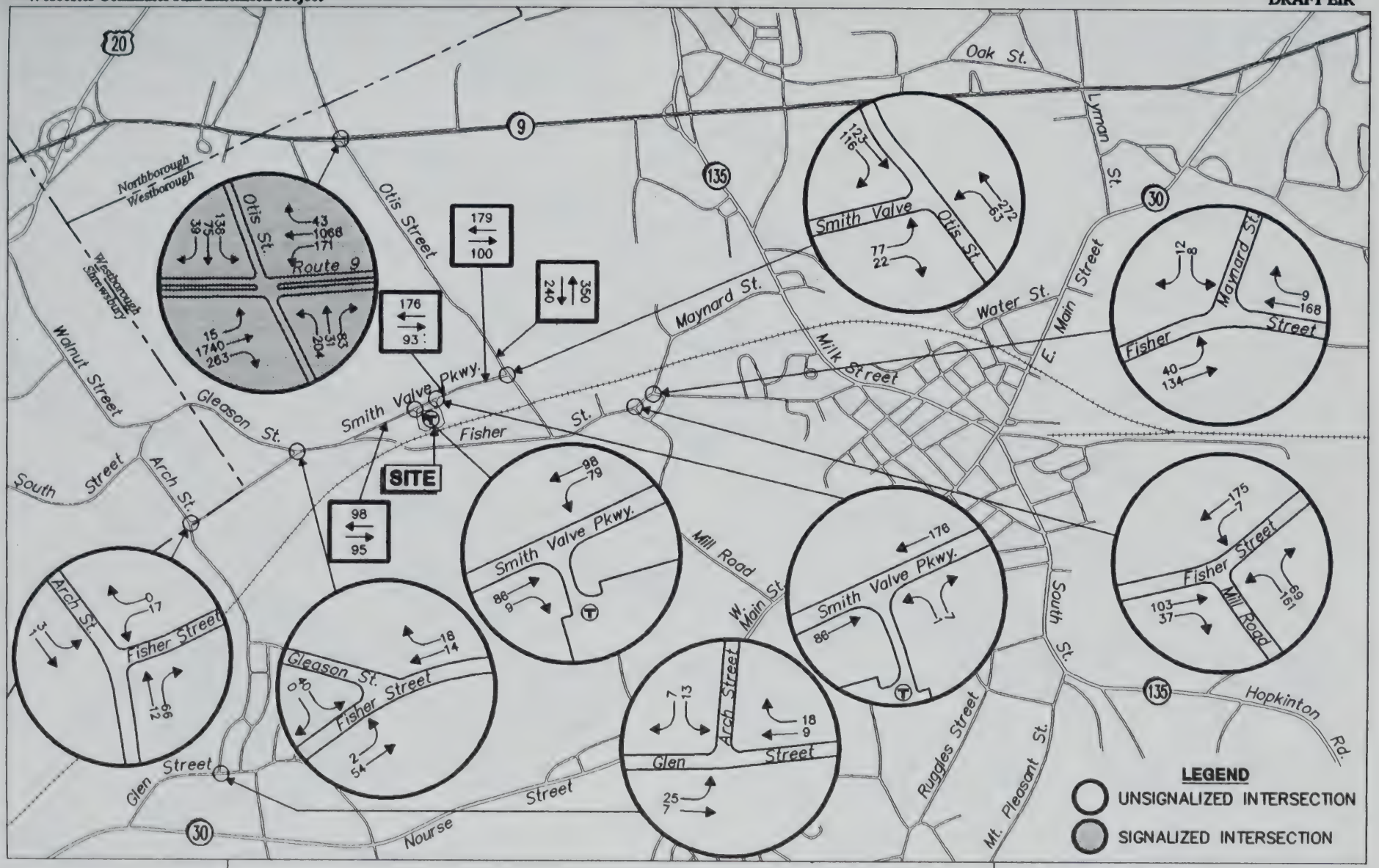


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-10

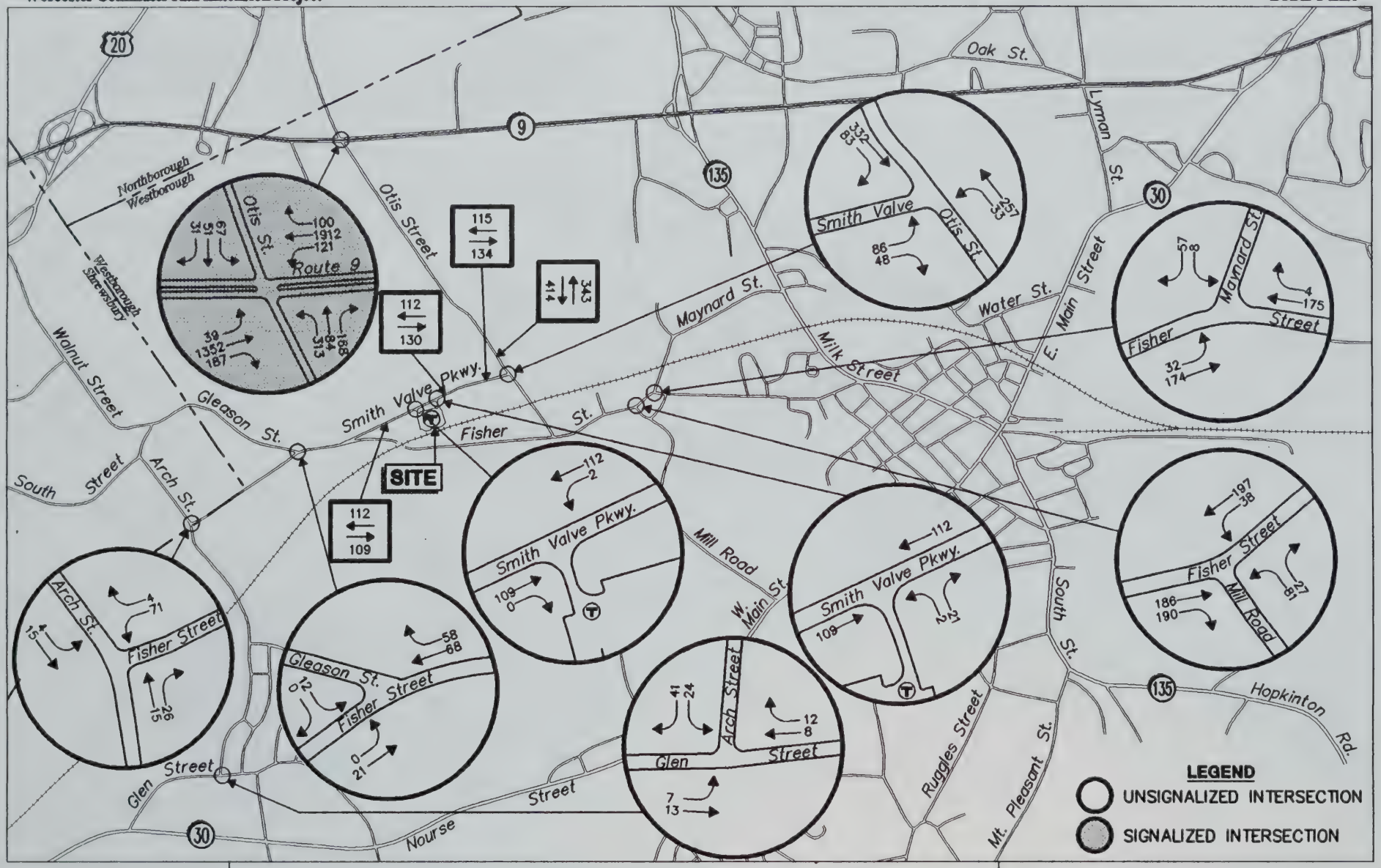


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

AM Peak Hour
7:30 - 8:30 A.M.
1996 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-11

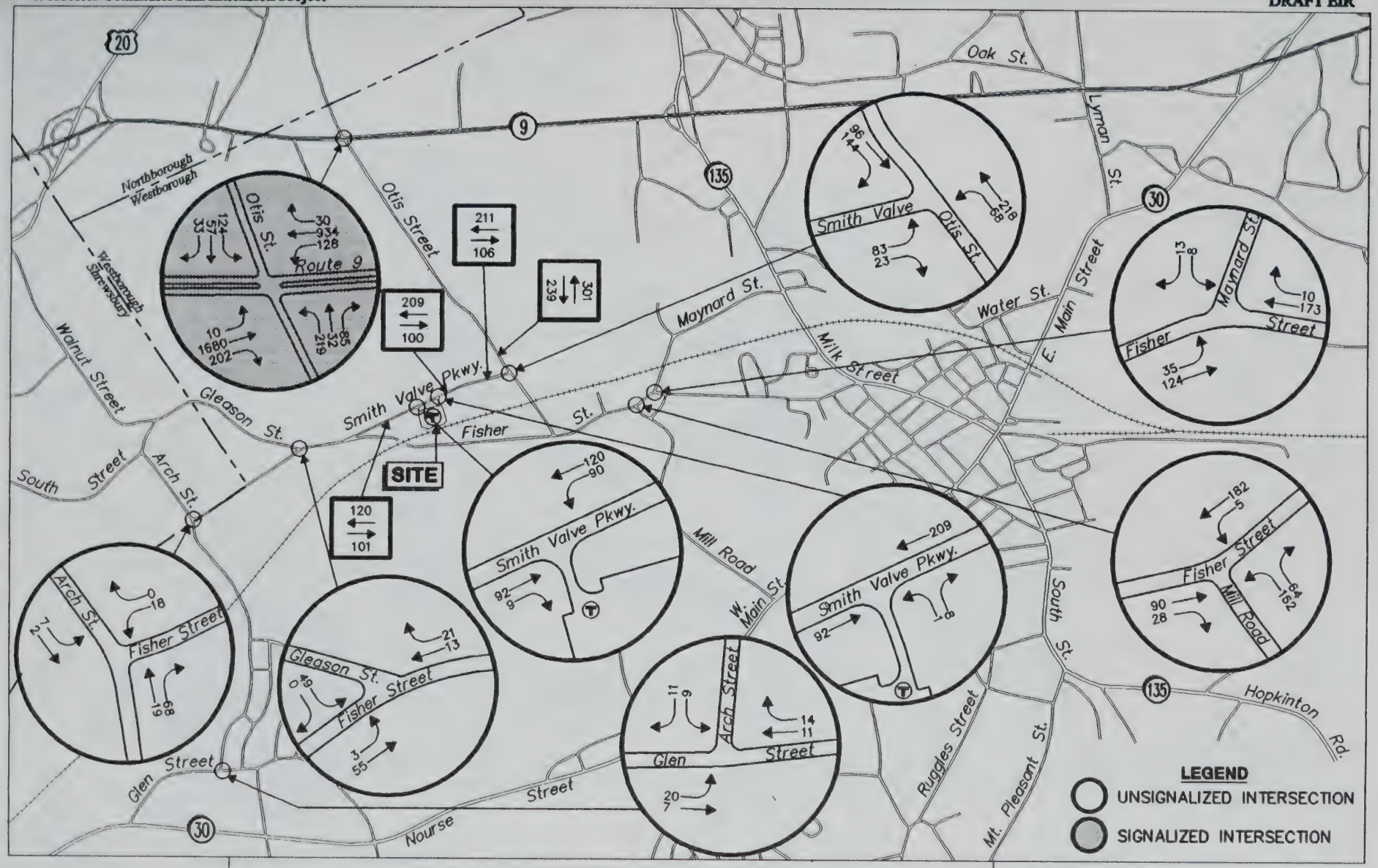


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

PM Peak Hour
4:45 - 5:45 P.M.
1996 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-12

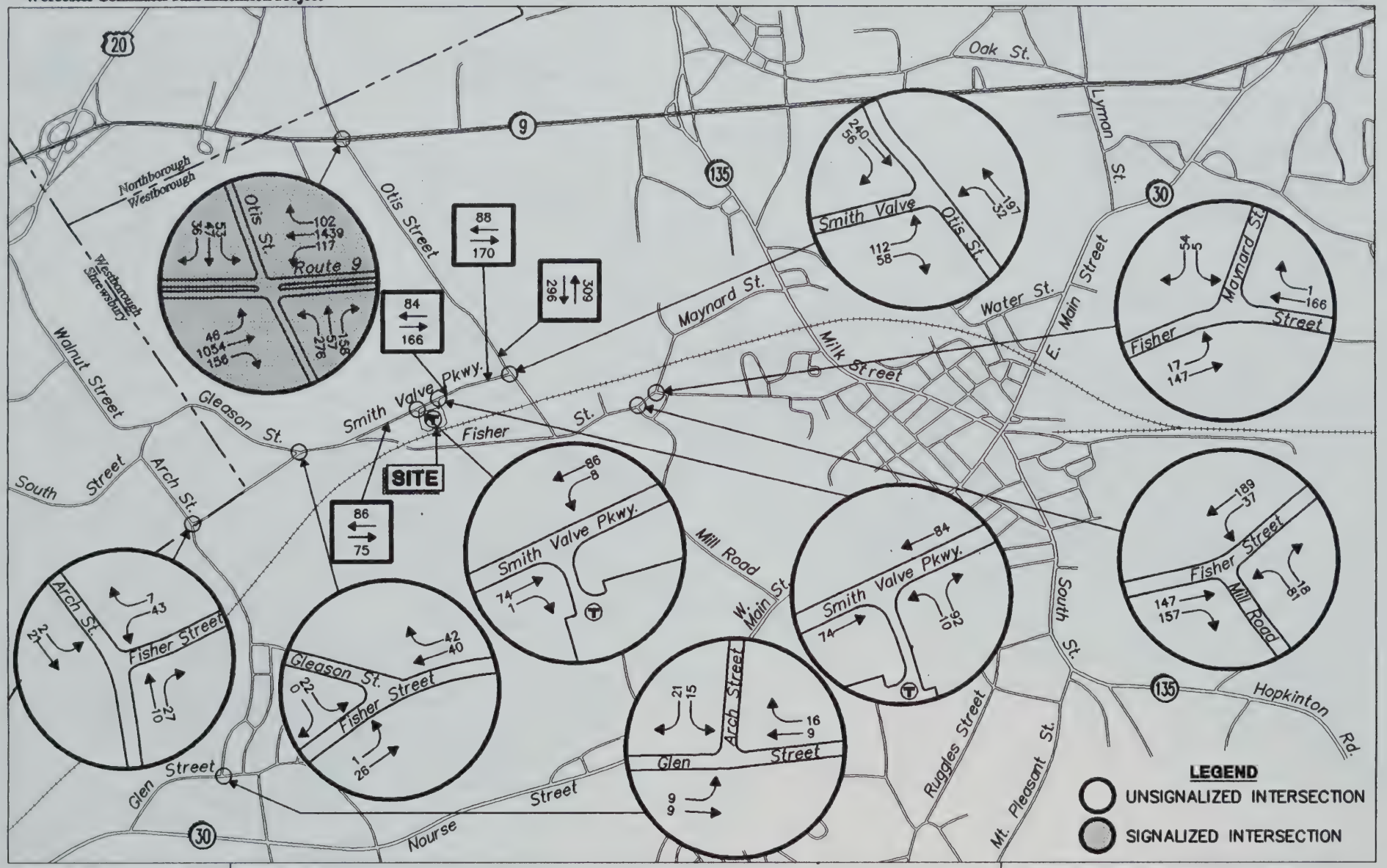


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

AM Peak Generator Hour
7:00 - 8:00 A.M.
1996 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

PM Peak Generator Hour
5:45 - 6:45 P.M.
1996 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-14

scenarios as it is expected that timing changes would be made as part of the proposed project.

Signalized Intersections

The signalized intersection was analyzed utilizing the same methodology as in the existing conditions. Table 1.6-6 lists the results of the signalized intersection analysis for the A.M. and P.M. peak hours under the "No Build" and "Build" conditions. The analysis was conducted utilizing the geometry proposed in the MHD intersection improvement project.

As shown in the table, the intersection and all individual movements will operate at acceptable levels of service under both the "No Build" and "Build" conditions.

No reduction in level of service is expected due to traffic entering or existing the proposed commuter rail station.

Table 1.6-6 1996 Peak Hour Signalized Intersection Level of Service*

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis**	C(15.9)	C(15.3)	C(16.4)	C(15.4)
Eastbound	C(16.4)	B(13.6)	C(16.4)	B(13.6)
Westbound	B(9.8)	B(11.5)	B(11.0)	B(11.5)
Northbound	D(26.1)	D(31.8)	D(26.3)	D(32.4)
Southbound	D(29.9)	D(32.9)	D(30.6)	D(32.9)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Analysis based on proposed MHD geometry*
** *Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.6-7. Under the 1996 "No Build" conditions, all of the intersection movements would operate at an acceptable level of service.

Table 1.6-7 1996 Peak Hour Unsignalized Intersection Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1105)	A(1003)	A(1103)	A(1001)
LT from RT from Gleason	A(729)	A(708)	A(722)	A(707)
Smith Valve and Site's W-DW				
LT from WB Smith Valve	-	-	A(951)	A(1017)
Smith Valve and Site's E-DW				
LT from Lot	-	-	A(576)	A(612)
RT from Lot	-	-	A(907)	A(867)
Otis and Smith Valve				
LT from NB Otis	A(905)	A(699)	A(828)	A(697)
LT and RT from Smith Valve	B(361)	C(256)	B(314)	C(228)
Fisher and Mill				
LT from WB Fisher	A(981)	A(726)	A(979)	A(722)
LT and RT from Mill	A(405)	B(320)	B(375)	B(317)
Fisher and Maynard				
LT from EB Fisher	A(907)	A(914)	A(906)	A(914)
LT and RT from Maynard	A(623)	B(683)	B(628)	B(683)
Arch and Fisher				
LT from SB Arch	A(1108)	A(1149)	A(1108)	A(1149)
LT and RT from Fisher	A(882)	A(835)	A(882)	A(835)
Glen and Arch				
LT from EB Glen	A(1144)	A(1170)	A(1144)	A(1170)
LT and RT from Arch	A(931)	A(955)	A(931)	A(955)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, all of the analyzed intersections would operate at acceptable levels of service. The level of service for traffic exiting Mill Street will drop to LOS "B" in the A.M. peak hour.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.6-8 lists the results of this analysis for the A.M. and P.M. peak hours.

Table 1.6-8 1996 Peak Hour Road Segment Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(1850)	C(1868)	C(1858)	C(1875)
Smith Valve West of Otis	B(2339)	B(2488)	B(2075)	B(2396)
Smith Valve West of Site	B(2348)	B(2460)	B(2355)	B(2475)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service under the "No Build" condition.

Under the 1996 "Build" condition, all analyzed roadway segments during the A.M. and P.M. roadway peak hours would operate at an acceptable level of service. No reduction in level of service ratings would occur between the "No Build" and "Build" conditions. The "Build" condition would result in minor reductions in reserve capacity for some segments.

Year 1996 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generator hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.6-9 for the 1996 "No Build" and "Build" conditions. The analysis was conducted utilizing the geometry proposed in the MHD intersection improvement project.

As shown in the table, the intersection and all individual movements operate at acceptable levels of service under both the "No Build" and "Build" conditions. A minor reduction in overall intersection level of service (LOS "B" to LOS "C") would occur in the P.M. peak generator hour.

Table 1.6-9 1996 Peak Generator Hour Signalized Intersection Level of Service*

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis**	B(13.9)	B(14.9)	B(14.4)	C(15.3)
Eastbound	B(13.2)	B(13.7)	B(13.2)	B(13.8)
Westbound	B(8.2)	B(12.1)	B(9.7)	B(12.1)
Northbound	D(28.2)	D(25.4)	D(28.6)	D(27.1)
Southbound	D(29.3)	D(27.5)	D(30.0)	D(27.5)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Analysis based on proposed MHD geometry*
* *Optimized signal timings were used for analysis*

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.6-10. Under the 1996 "No Build" conditions, all of the analyzed intersections would operate at acceptable levels of service.

Under the 1996 "Build" conditions, all of the analyzed intersections would operate at acceptable levels of service.

Level of service ratings would decline for traffic exiting Smith Valve Parkway to Otis Street to LOS "B" and LOS "C" for the A.M. and P.M. peak generator hours, respectively. The level of service for traffic existing Mill Road to Fisher Street would decline to LOS "B" in the A.M. peak generator hour.

Table 1.6-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1101)	A(1057)	A(1100)	A(1048)
LT from RT from Gleason	A(717)	A(735)	A(709)	A(730)
Smith Valve and Site's W-DW				
LT from WB Smith Valve	-	-	A(934)	A(1049)
Smith Valve and Site's E-DW				
LT from Lot	-	-	A(542)	A(667)
RT from Lot	-	-	A(899)	A(835)
Otis and Smith Valve				
LT from NB Otis	A(910)	A(810)	A(822)	A(803)
LT and RT from Smith Valve	A(404)	A(405)	B(346)	C(288)
Fisher and Mill				
LT from WB Fisher	A(1007)	A(811)	A(1004)	A(787)
LT and RT from Mill	A(421)	B(369)	B(387)	B(356)
Fisher and Maynard				
LT from EB Fisher	A(906)	A(942)	A(905)	A(941)
LT and RT from Maynard	A(634)	A(728)	A(638)	A(727)
Arch and Fisher				
LT from SB Arch	A(1094)	A(1155)	A(1094)	A(1155)
LT and RT from Fisher	A(864)	A(875)	A(864)	A(875)
Glen and Arch				
LT from EB Glen	A(1151)	A(1162)	A(1151)	A(1162)
LT and RT from Arch	A(973)	A(972)	A(973)	A(972)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.6-11 lists the results of this analysis for the A.M. and P.M. peak generator hours.

Table 1.6-11 1996 Peak Generator Hour Road Segment Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(2049)	C(2120)	C(2079)	C(2098)
Smith Valve West of Otis	B(2286)	B(2516)	B(2016)	B(2184)
Smith Valve West of Site	B(2278)	B(2522)	B(2300)	B(2481)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service under both the "No Build" and "Build" conditions. No reduction in level of service is anticipated to occur between the "No Build" and "Build" conditions. The "Build" condition would result in a minor reduction in reserve capacity for some segments.

Traffic impacts associated with the rehabilitation or reconstruction of bridges carrying the railroad over East Main Street, Water Street, Maynard Street, and Arch Street will not develop since the bridges are structurally sound. The Fisher Street bridge over the railroad is closed and scheduled for removal.

Year 1996 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.6-12 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in Table 1.6-12 it is expected that many of the intersections including the site's two driveways will see 10 percent of its peak hour traffic in 1996 to be site related. The intersection of Otis and Smith Valve Parkway is anticipated to see 12.8% of its' A.M. peak hour traffic to be site related

It is anticipated that all three road segments will see more than 10.0% of their traffic to be site related. The road segments are Smith Valve Parkway West of Otis and Otis North of Smith Valve parkway.

Table 1.6-12 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Fisher and Gleason	7.8%	1.3%
Smith Valve and Site's West DW	32.7%	1.8%
Smith Valve and Site's East DW	32.2%	10.2%
Otis and Smith Valve Parkway	12.8%	2.7%
Fisher and Mill	4.3%	0.8%
Fisher and Maynard	0.5%	0.0%
Route 9 and Otis	1.6%	0.4%
Arch and Fisher	2.0%	0.0%
Glen and Arch	2.5%	0.0%
Roadway Segment		
Smith Valve West of Site	5.2%	0.9%
Smith Valve West of Otis	30.8%	9.2%
Otis North of Smith Valve	10.5%	2.3%

Site generated traffic as a percentage of total traffic

Year 1996 Westborough Station Only

In order to address an upper limit, worst case situation with regard to traffic impacts on Westborough Streets, an analysis was performed which considered that the Westborough commuter station was the only commuter station built by 1996 (in addition to a Worcester Station).

The 1996 "No Build" traffic volumes, for both the peak hours and peak generator hours, were previously presented and serve as the same base for the "Westborough Station Only" as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Westborough Station Only)

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership for the Westborough Station, employing an unconstrained parking supply. In 1996, the Westborough Station is projected to attract a total of 507 daily round trip commuters, 466 of which would be Park'n'Ride patrons. These patrons are expected to reside in the Towns of Westborough, Upton, Berlin, Northborough, Shrewsbury, Grafton, Sutton, Boylston,

Northbridge, and Millbury. The number of patrons who originate from each community is shown in Table 1.6-13. The ridership has been adjusted to reflect peak period usage, which is 94% of the total daily demand.

Table 1.6-13 Projected Patrons of Westborough Station Only Year 1996

City/Town	Riders*
Westborough	85
Upton	118
Berlin	5
Northborough	89
Shrewsbury	77
Grafton	37
Sutton	17
Boylston	18
Northbridge	26
Millbury	4
TOTAL	**476**

* *Adjusted for Peak Period Demand*

Year 1996 Trip Distribution and Assignment (Westborough Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.6-14 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.6-14 MBTA Ridership Distribution (Westborough Station Only)	
Inbound Train	**Patrons**
502A	93
504A	154
506A	155
510	74
TOTAL	**476**
Outbound Train	**Patrons**
515A	67
519	110
521	110
521A	165
523	24
TOTAL	**476**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Westborough Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Westborough the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:45 to 5:45 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 7:00 to 8:00 A.M. and from 5:45 to 6:45 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside

in Westborough would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to major roadways leading from their town to the proposed station.

The primary access route from the Town of Northborough would be westbound Route 9 to Otis Street to Smith Valve Parkway. From the Town of Shrewsbury access would be Route 9 eastbound to Otis Street to Smith Valve Parkway. The primary access route from the Town of Upton would be South Street, Route 135, to West Main Street to Mill Road to Fisher Street to Otis Street to Smith Valve Parkway.

Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.6-15 shows the percentage of station related traffic utilizing the study are roadways for the 1996 "Build" condition.

Year 1996 "Build" Traffic Volumes (Westborough Station Only)

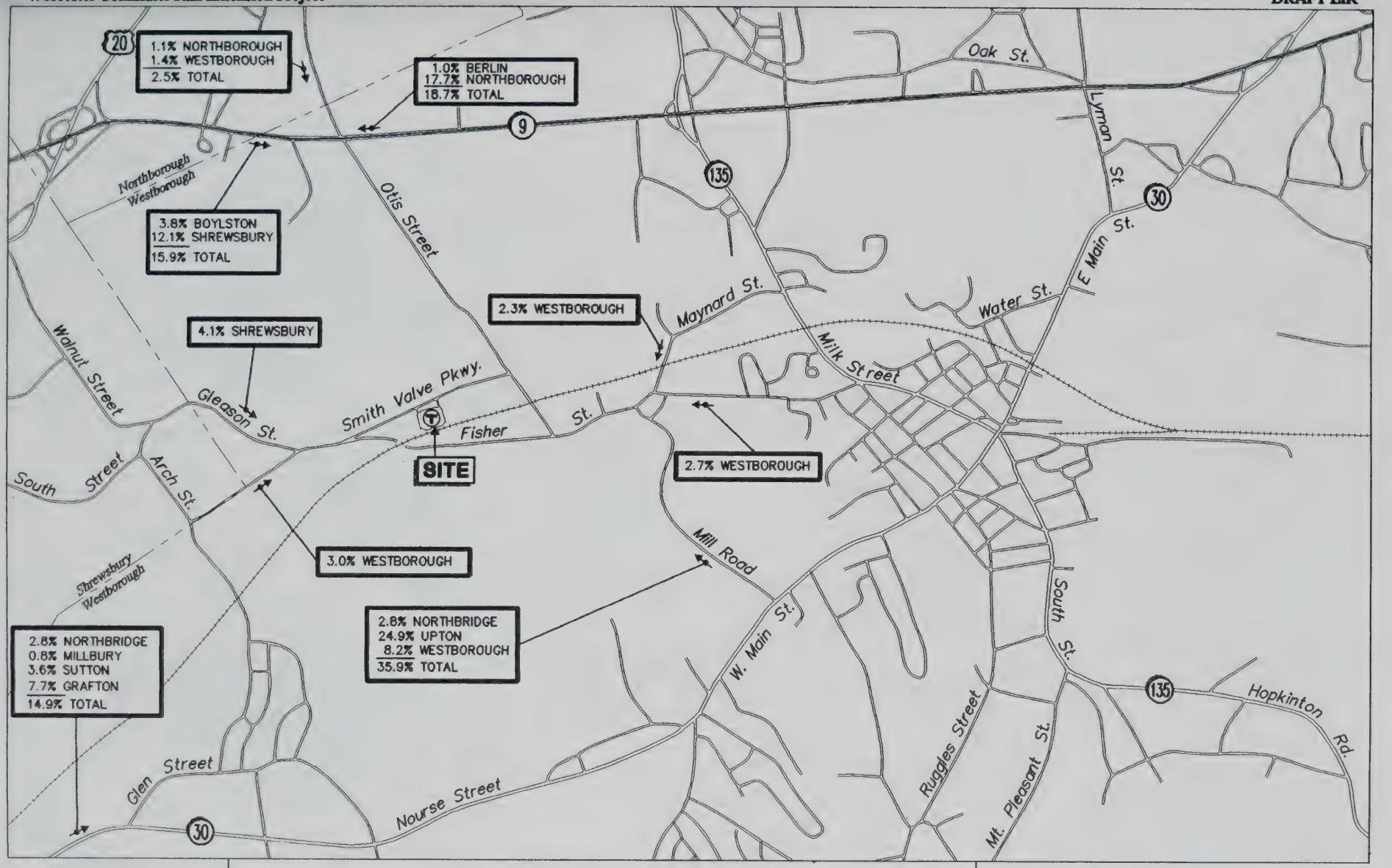
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Westborough station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Westborough. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways. This results in a "worst case" analysis. Figures 1.6-16 and 1.6-17 show the A.M. and P.M. peak hour traffic volumes, respectively. Figures 1.6-18 and 1.6-19 show the A.M. and P.M. peak generator hour volumes, respectively.

Year 1996 Peak Hour Level of Service (Westborough Station Only)

The same study area elements that were analyzed under the 1992 existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. Except for the Route 9/Otis Street intersection, the analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis that change from the existing conditions. Roadway geometrics, etc. remain unchanged. As previously noted, MHD is currently designing modifications to the Route 9/Otis Street intersection. Since it is anticipated that the modifications will be in place by 1996, the analysis of the Route 9/Otis Street Intersection incorporated the proposed modifications. Signal timings were optimized for both the

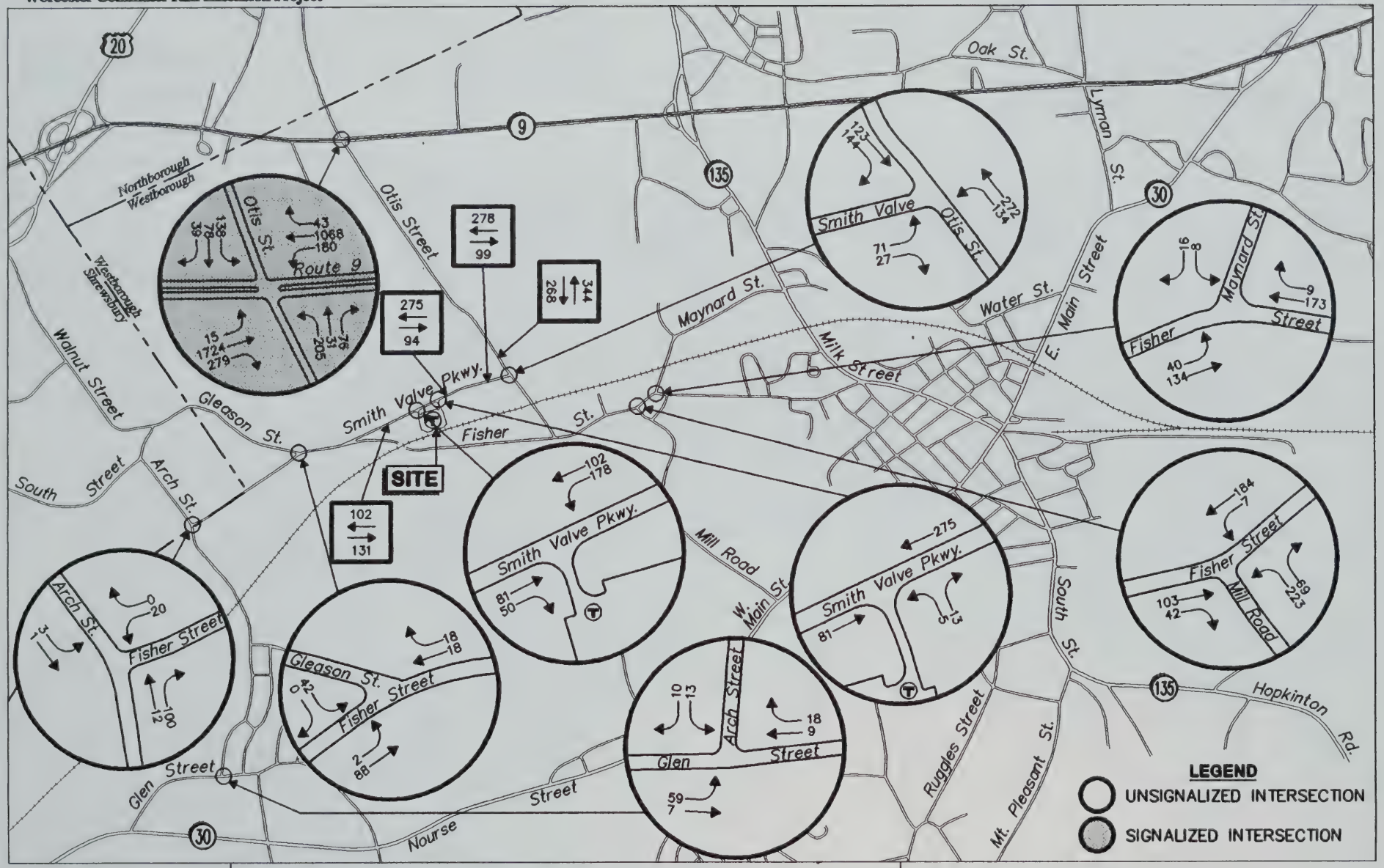


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

Distribution of Commuter Rail Station Traffic
1996 BUILD Westborough Only
WESTBOROUGH STATION

FIGURE 1.6-15



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

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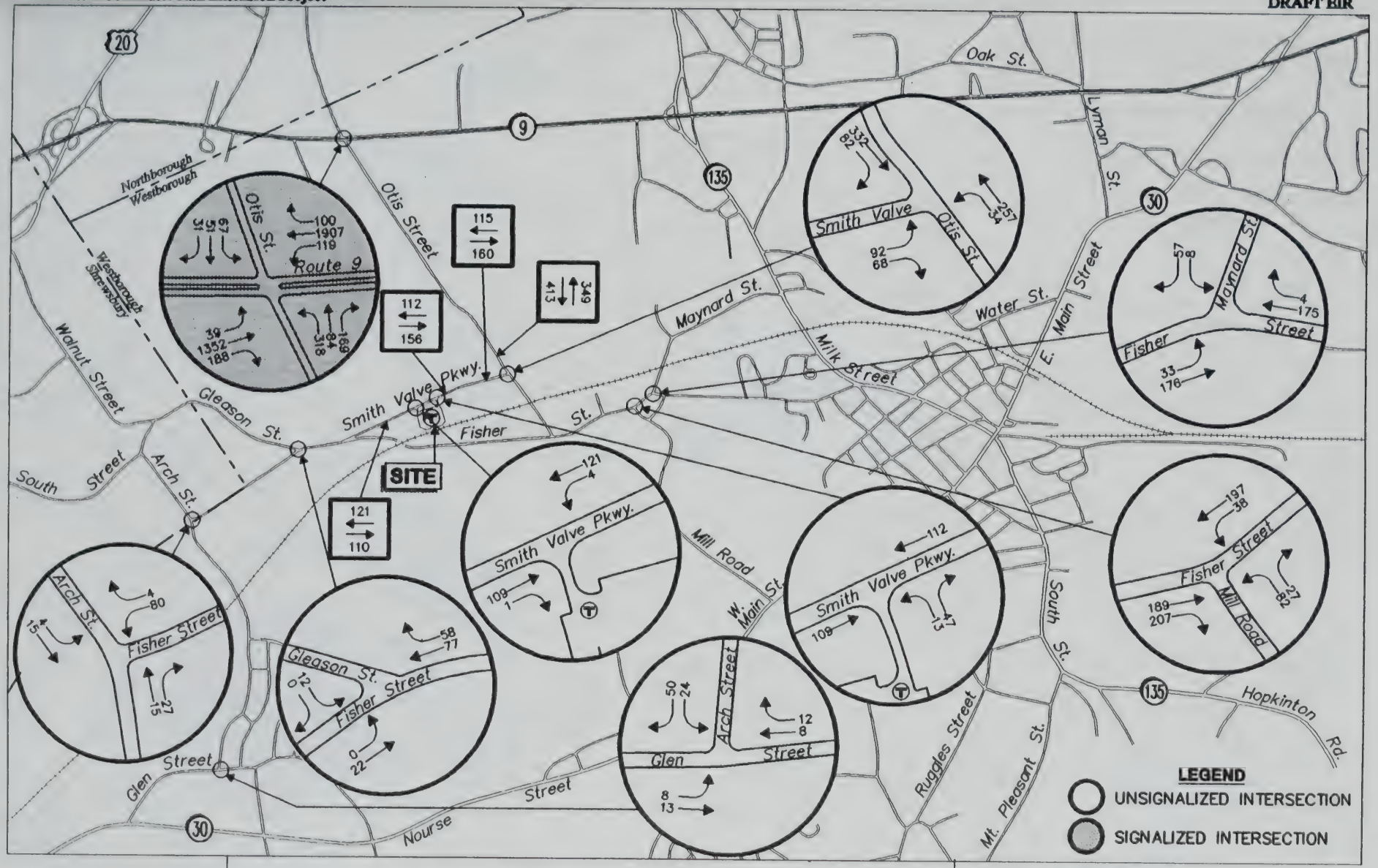
AM Peak Hour
7:30 - 8:30 A.M.
BUILD YEAR 1996 Westborough Only
WESTBOROUGH STATION

FIGURE 1.6-16



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
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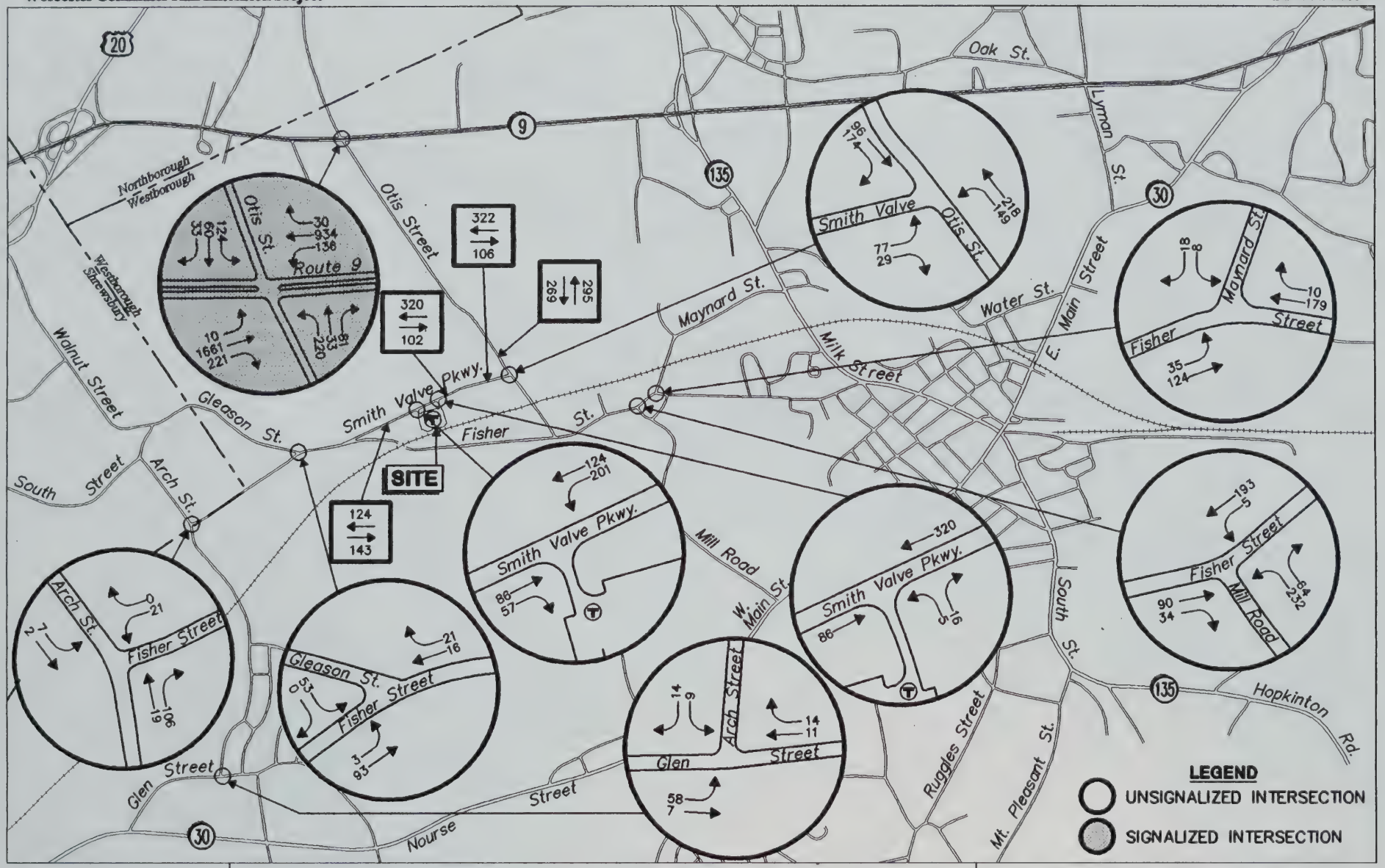
P.M. Peak Hour
4:45 - 5:45 P.M.
1996 BUILD Westborough Only
WESTBOROUGH STATION

FIGURE 1.6-17

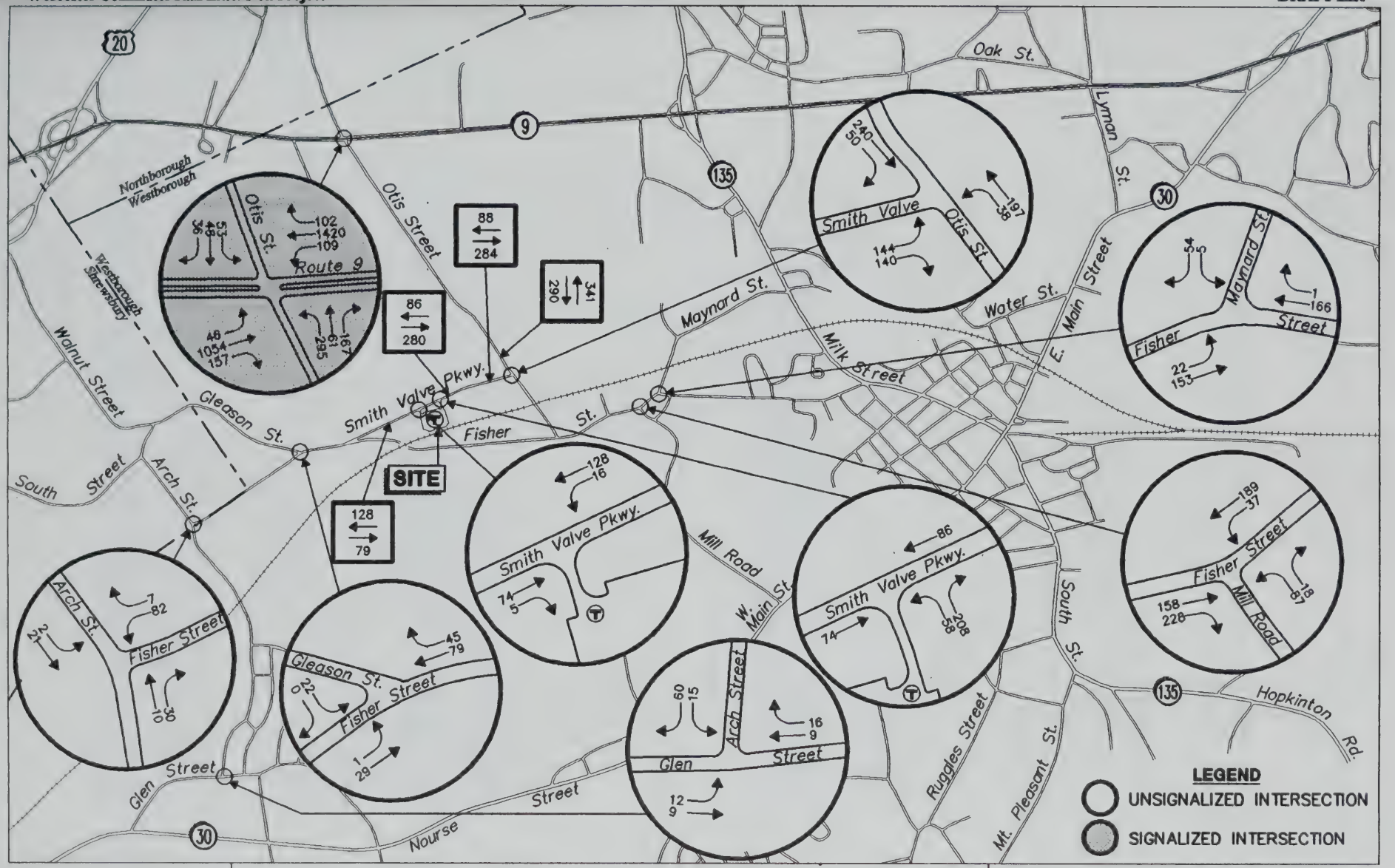


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
1996 BUILD Westborough Only
WESTBOROUGH STATION

FIGURE 1.6-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
1996 BUILD Westborough Only
WESTBOROUGH STATION

FIGURE 1.6-19

"No Build" and "Build" scenarios as it is expected that timing changes would be made as part of the proposed project.

Signalized Intersections

The intersection of Route 9 and Otis Street was analyzed using the same methodology as in the existing condition. The results of the analysis for the A.M. and P.M. peak hours area presented in Table 1.6-15. The analysis was conducted utilizing the geometry proposed in the MHD intersection improvement project.

As shown in the table, the intersection and all individual movements would operate at acceptable levels of service under both the "No Build" and "Build" conditions.

No reduction in level of service will result due to traffic entering and exiting the proposed commuter rail station.

Table 1.6-15 1996 Peak Hour Signalized Intersection Level of Service (Westborough Station Only)*

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis**	C(15.9)	C(15.3)	C(16.6)	C(15.5)
Eastbound	C(16.4)	B(13.6)	C(16.5)	B(13.6)
Westbound	B(9.8)	B(11.5)	B(11.4)	B(11.4)
Northbound	D(26.1)	D(31.8)	D(26.8)	D(33.1)
Southbound	D(29.9)	D(32.9)	D(31.4)	D(32.9)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Analysis based on proposed MHD geometry*
** *Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as was used in the existing condition. The results of the analysis for the A.M. and P.M. peak hours are presented in Table 1.6-16.

As shown in the table, all intersection movements will operate at acceptable levels of service during the A.M. and P.M. peak hours under the "No Build" condition.

Under the "Build" condition all intersection movements will operate at acceptable levels of service for both the A.M. and P.M. peak hours. There will be minor

reductions in levels of service for traffic egressing Smith Valve Parkway to Otis Street in the A.M. peak hour (LOS "B" to LOS "C") and for traffic egressing Mill Road to Fisher Street in the A.M. peak hour (LOS "A" to LOS "C").

Table 1.6-16 1996 Peak Hour Unsignalized Intersection Level of Service (Westborough Station Only)

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1105)	A(1003)	A(1099)	A(991)
LT from RT from Gleason	A(729)	A(708)	A(678)	A(696)
Smith Valve and Site's W-DW				
LT from WB Smith Valve	-	-	A(807)	A(1014)
Smith Valve and Site's E-DW				
LT from Lot	-	-	A(492)	A(601)
RT from Lot	-	-	A(906)	A(841)
Otis and Smith Valve				
LT from NB Otis	A(905)	A(699)	A(735)	A(697)
LT and RT from Smith Valve	B(361)	C(256)	C(259)	C(218)
Fisher and Mill				
LT from WB Fisher	A(981)	A(726)	A(974)	A(705)
LT and RT from Mill	A(405)	B(320)	C(286)	B(308)
Fisher and Maynard				
LT from EB Fisher	A(907)	A(914)	A(901)	A(913)
LT and RT from Maynard	A(623)	A(683)	A(643)	A(682)
Arch and Fisher				
LT from SB Arch	A(1108)	A(1149)	A(1071)	A(1148)
LT and RT from Fisher	A(882)	A(835)	A(859)	A(824)
Glen and Arch				
LT from EB Glen	A(1144)	A(1170)	A(1110)	A(1169)
LT and RT from Arch	A(931)	A(955)	A(907)	A(953)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments were analyzed using the same methodology as was used in the existing condition. The results of the analysis are presented in Table 1.6-17.

As shown in the table, all of the roadway segments analyzed would be expected to operate at acceptable levels of service under both the "No Build" and "Build" conditions. Smith Valve Parkway west of Otis Street will experience a minor reduction in level of service, from LOS "B" to LOS "C", during the A.M. peak hour. The "Build" condition would also result in a minor reduction in reserve capacity for some segments.

Table 1.6-17 1996 Peak Hour Road Segment Level of Service (Westborough Station Only)

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(1850)	C(1868)	C(1881)	C(1878)
Smith Valve West of Otis	B(2339)	B(2488)	C(1782)	B(2304)
Smith Valve West of Site	B(2348)	B(2460)	B(2231)	B(2446)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 Peak Generator Hour Level of Service (Westborough Station Only)

Signalized Intersections

Analysis was also performed for the peak generator hours. The results of the signalized intersection analysis for the A.M. and P.M. peak generator hours are presented in Table 1.6-18. The analysis was conducted utilizing the geometry proposed in the MHD intersection improvement project.

As shown in the table, the intersection and all individual movements will operate at acceptable levels of service under both the "No Build" and "Build" conditions. A minor reduction in intersection level of service will occur in the P.M. peak generator hour.

Table 1.6-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Westborough Station Only)*

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis**	B(13.9)	B(14.9)	B(14.6)	C(15.7)
Eastbound	B(13.2)	B(13.7)	B(13.2)	B(13.8)
Westbound	B(8.2)	B(12.1)	B(10.2)	B(11.8)
Northbound	D(28.2)	D(25.4)	D(29.1)	D(29.3)
Southbound	D(29.3)	D(27.5)	D(30.7)	D(27.7)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Analysis based on proposed MHD geometry*
** *Optimized signal timings were used for analysis*

Unsignalized Intersections

The results of unsignalized intersection analysis for the A.M. and P.M. peak generator hours are presented in Table 1.6-19.

As shown in the table, all intersection movements will operate at acceptable levels of service under the "No Build" condition.

Under the "Build" condition, the intersection movements will operate at acceptable levels of service. There will be reductions in level of service for traffic egressing Smith Valve Parkway to Otis Street in the A.M. peak generator hour (LOS "A" to LOS "C") and for traffic egressing Mill Road to Fisher Street also in the A.M. peak generator hour (LOS "A" to LOS "C").

Table 1.6-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Westborough Station Only)

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1101)	A(1057)	A(1097)	A(1002)
LT from RT from Gleason	A(717)	A(735)	A(660)	A(682)
Smith Valve and Site's W-DW				
LT from WB Smith Valve	-	-	A(772)	A(1036)
Smith Valve and Site's E-DW				
LT from Lot	-	-	A(454)	A(617)
RT from Lot	-	-	A(898)	A(721)
Otis and Smith Valve				
LT from NB Otis	A(910)	A(810)	A(719)	A(803)
LT and RT from Smith Valve	A(404)	A(405)	C(276)	C(211)
Fisher and Mill				
LT from WB Fisher	A(1007)	A(811)	A(998)	A(715)
LT and RT from Mill	A(421)	B(369)	C(287)	B(314)
Fisher and Maynard				
LT from EB Fisher	A(906)	A(942)	A(899)	A(936)
LT and RT from Maynard	A(636)	A(728)	A(653)	A(725)
Arch and Fisher				
LT from SB Arch	A(1094)	A(1155)	A(1053)	A(1152)
LT and RT from Fisher	A(684)	A(875)	A(839)	A(825)
Glen and Arch				
LT from EB Glen	A(1151)	A(1162)	A(1113)	A(1159)
LT and RT from Arch	A(973)	A(972)	A(951)	A(972)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The results of the roadway segment analysis for the peak generator hours are presented in Table 1.6-20.

As shown in the table, all of the roadway segments will operate at acceptable levels of service under both the "No Build" and "Build" conditions. Smith Valve Parkway west of Otis Street will experience a decline in level of service, from LOS "B" to LOS "C", during both the A.M. and P.M. peak generator hours.

Table 1.6-20 1996 Peak Generator Hour Road Segment Level of Service (Westborough Station Only)

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(2049)	C(2120)	C(2119)	C(2020)
Smith Valve West of Otis	B(2286)	B(2516)	C(1780)	C(1913)
Smith Valve West of Site	B(2278)	B(2522)	B(2247)	B(2221)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis (Westborough Station Only)

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.6-21 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in Table 1.6-21 it is expected that many of the intersections including the site's two driveways will see 10 percent of its peak hour traffic in 1996 to be site related, particularly in the A.M. peak hour.

It is anticipated that all three road segments analyzed will see more than 10.0% of their traffic to be site related.

Table 1.6-21 1996 "Build" Condition - 10% Analysis (Westborough Station Only)		
Intersection	Peak Hours	
	A.M.	P.M.
Fisher and Gleason	30.9	8.3%
Smith Valve and Site's West DW	56.7%	7.7%
Smith Valve and Site's East DW	48.9%	22.8%
Otis and Smith Valve Parkway	24.8%	5.9%
Fisher and Mill	15.9%	3.6%
Fisher and Maynard	2.9%	0.7%
Route 9 and Otis	3.2%	0.5%
Arch and Fisher	27.2%	6.9%
Glen and Arch	31.9%	8.9%
Roadway Segment		
Smith Valve West of Site	23.6%	6.1%
Smith Valve West of Otis	50.7%	18.5%
Otis North of Smith Valve	14.9%	3.1%
Site generated traffic as a percentage of total traffic		

Year 2001 Conditions

Similar to the year 1996 conditions, an analysis was performed for the projected "No Build" and "Build" traffic conditions in the year 2001. Procedures and methodology for this analysis were the same as in the 1996 condition analysis. A detailed description of the analysis methodology is presented in Section 1.1 of this report.

Year 2001 "No Build" Traffic Volumes

To determine the year 2001 "No Build" traffic volumes, the traffic volumes under the 1996 "No Build" conditions were adjusted based on anticipated growth in population and employment throughout the region. A growth rate of 1.5 percent per year was applied to the 1996 "No Build" traffic volumes based on current employment projections which show positive growth in 1996 of 1.4% and in 1997 of 1.6%.

There is one possible large site specific project identified which should be added to the "No Build" traffic volumes for the year 2001. The project, Fountainhead Plaza, was originally scheduled for opening in 1988. The project, which would occupy land in Westborough and Northborough, has been plagued by problems in obtaining

permits. The project is primarily retail space and may never be built in its present form. The study area was first analyzed without the Fountainhead Plaza project and as a possible option for the year 2001 the intersection of Route 9 and Otis Street was analyzed again with the Fountainhead Plaza project in operation.

Figures 1.6-20 and 1.6-21 show the projected 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. roadway peak hours, respectively. Figures 1.6-22 and 1.6-23 show the projected year 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak generator hours, respectively.

Year 2001 Trip Generation/Parking

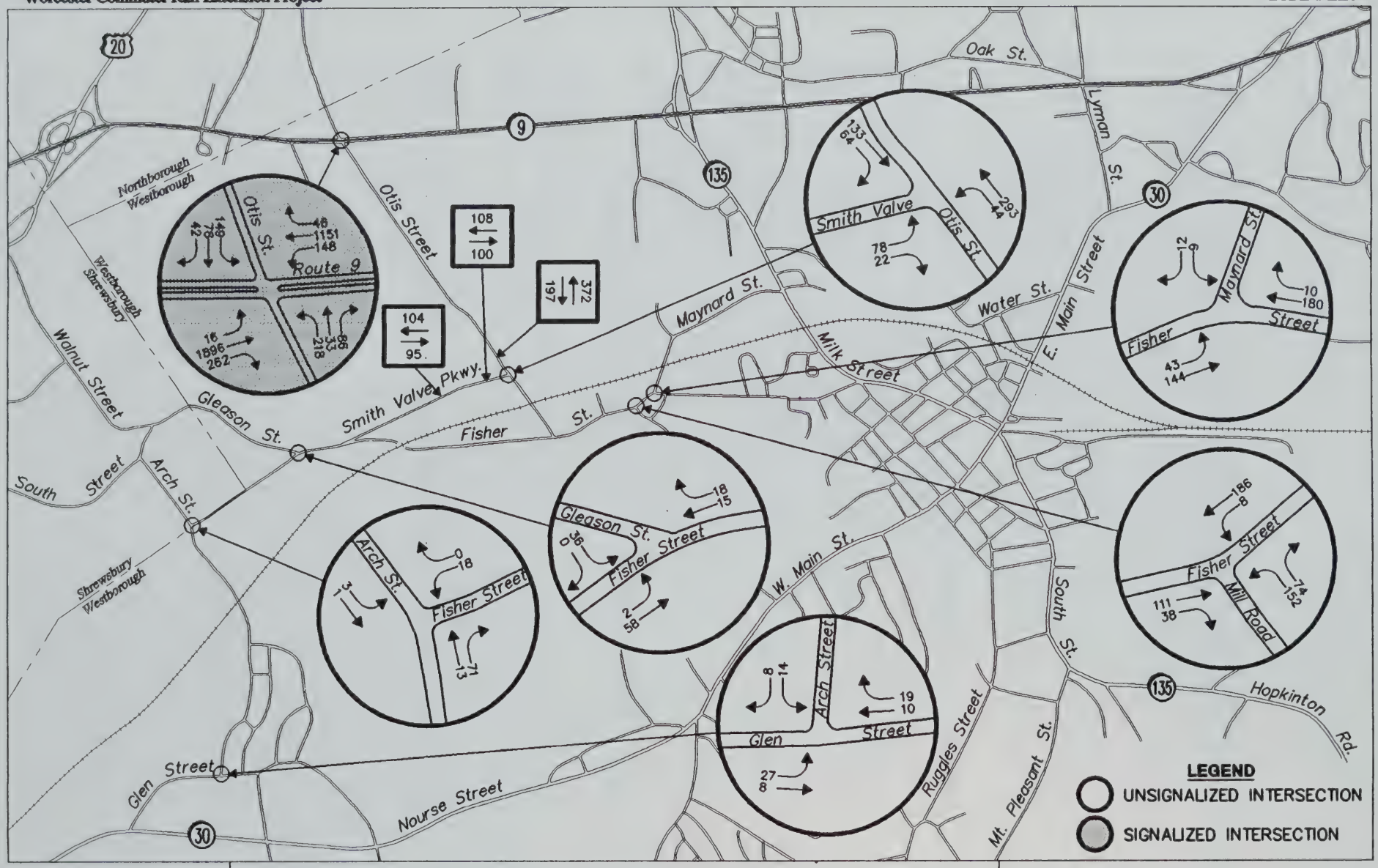
Minor shifting is expected to occur in the town of origin of the patrons utilizing the proposed Westborough Station from the projections presented in the 1996 conditions. CTPS projected that by the year 2001, the proposed Westborough commuter rail station would attract 230 commuters, 212 of which are projected to be "Park'n'Riders". The increase is mostly due to a shifting of commuters utilizing the Southborough Station. Some residents of Westborough were originally assigned to the Southborough Station due to the proximity of the station to their neighborhood. By the year 2001, demand for parking spaces will exceed the capacity of the Southborough station. Westborough residents who are unable to gain access in Southborough are expected to utilize the Westborough station. Thus, the demand for spaces at this station will increase.

These patrons are projected to reside in the Towns of Westborough, Northborough, Shrewsbury and Upton. The number of patrons originating from each town are shown in Table 1.6-22. The ridership has been adjusted to reflect peak period usage, which is 94% of total daily demand.

Table 1.6-22 Projected Patrons of Westborough Station Year 2001

Town	Riders*
Westborough	22
Shrewsbury	66
Northborough	90
Upton	39
TOTAL	**217**

* *Adjusted for peak period demand*



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 NO BUILD
WESTBOROUGH STATION

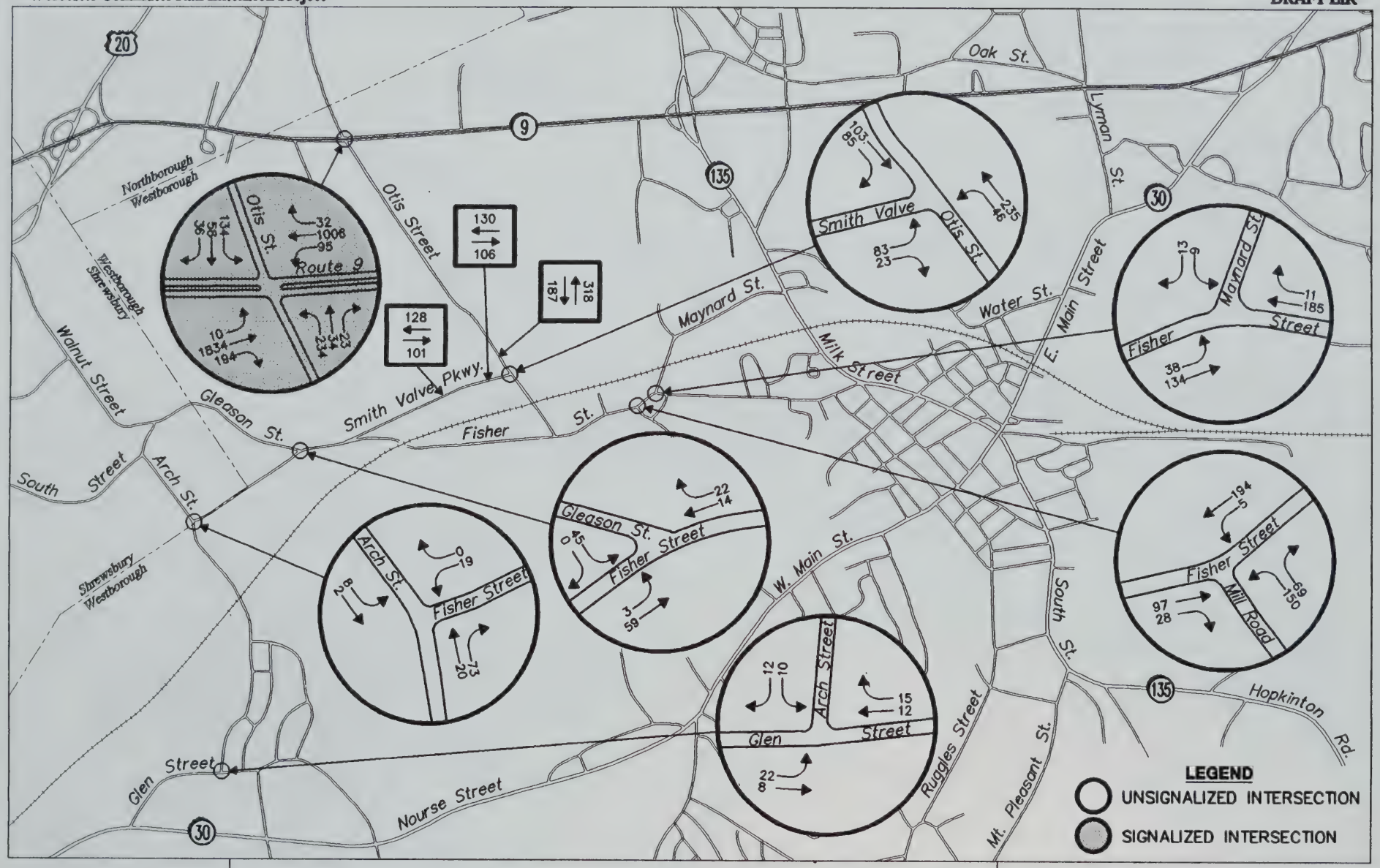
FIGURE 1.6-20

Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

P.M. Peak Hour
4:45 - 5:45 P.M.
2001 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-21



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
2001 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-22

Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
2001 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-23

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand the those that depart at other times.

The distribution of ridership per train is the same as under the 1996 conditions. Table 1.6-23 lists the typical distribution of ridership based on arrival/departure time in Boston.

Table 1.6-23 MBTA Ridership Distribution

Inbound Train	Patrons
502A	43
504A	70
506A	70
510	34
TOTAL	**217**
Outbound Train	**Patrons**
515A	30
519	50
521	50
521A	76
523	11
TOTAL	**217**

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Westborough would utilize a variety of travel routes, depending on the location of their residence. Due to the minor shifts in town of origin of the patrons addressed previously, the percentage of site generated traffic on the study area roadways is slightly different than under the 1996 conditions.

Riders originating in towns outside that in which the station is located were assigned to major roadways leading from their town to the proposed station. Figure 1.6-24 shows the percentage of station related traffic utilizing the study area roadways.

Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

- the projected year 2001 "No Build" traffic volumes.
- traffic specifically diverted to the proposed Westborough station.

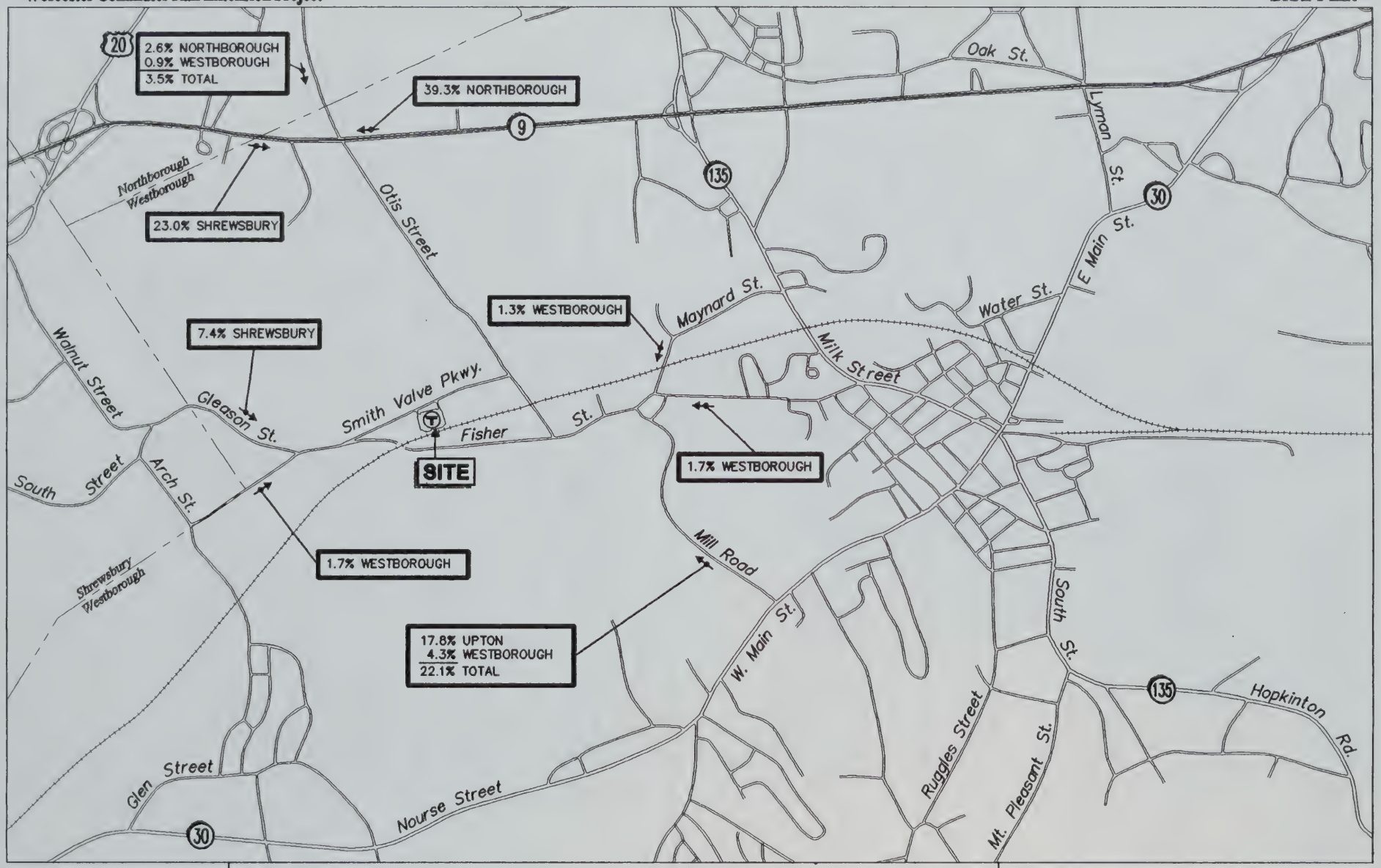
A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Westborough. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways. This results in a "worst case" analysis.

Figures 1.6-25 and 1.6-26 show the projected 2001 "Build" A.M. and P.M. peak roadway hour traffic volumes respectively. Figures 1.6-27 and 1.6-28 show the A.M. and P.M. peak generator hour volumes, for the projected year 2001 "Build" condition, respectively.

Year 2001 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing and 1996 "No Build" conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. The traffic volumes are the only parameter in the analysis that changes from the existing conditions. Roadway geometrics remain unchanged, except as noted below:

- As previously noted in the year 1996 conditions, the Massachusetts Highway Department (MHD) is proposing geometric improvements at the Route 9/Otis Street intersection. As with the 1996 conditions, this intersection was analyzed utilizing the geometry proposed in the MHD intersection improvement project.



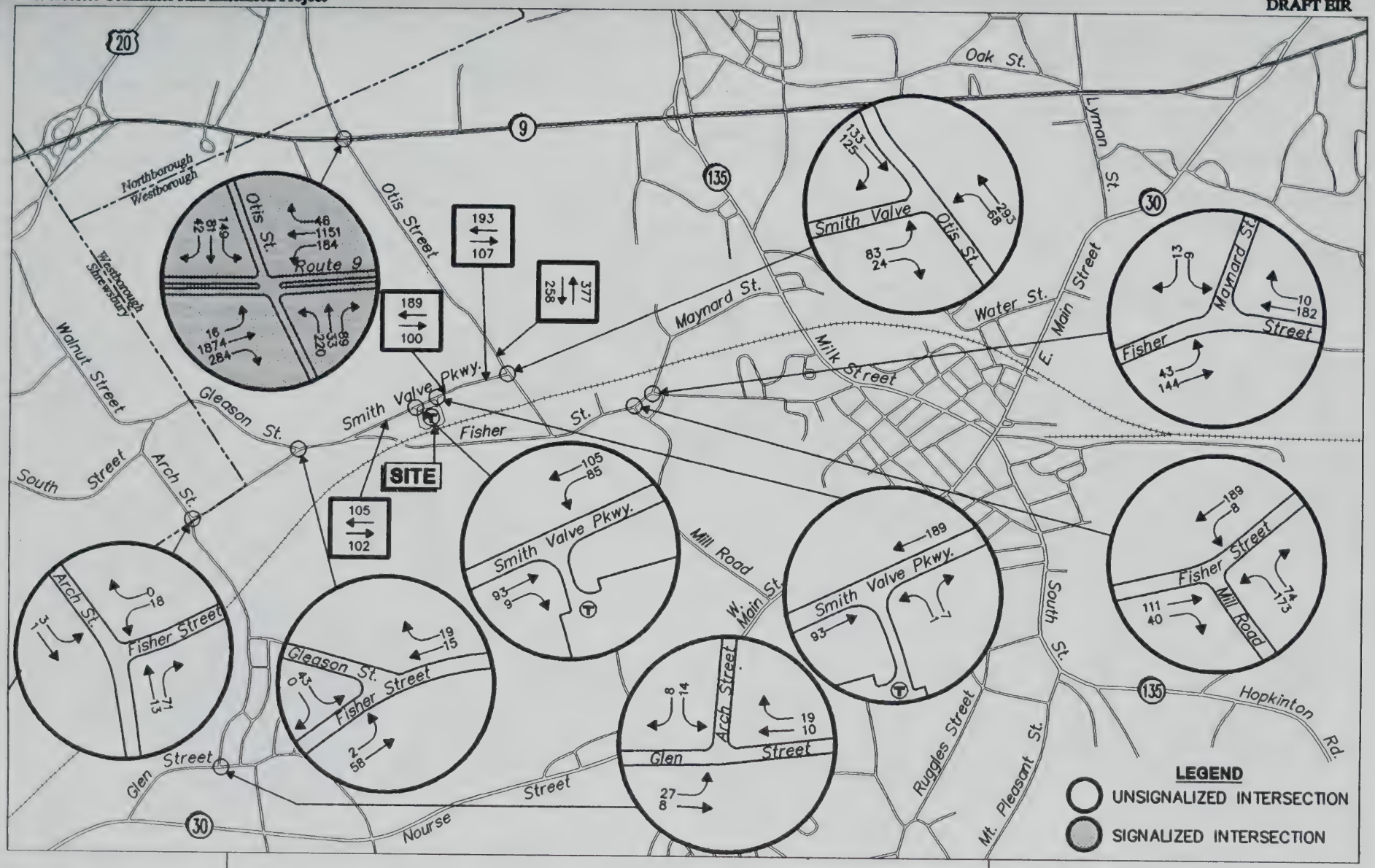
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-24



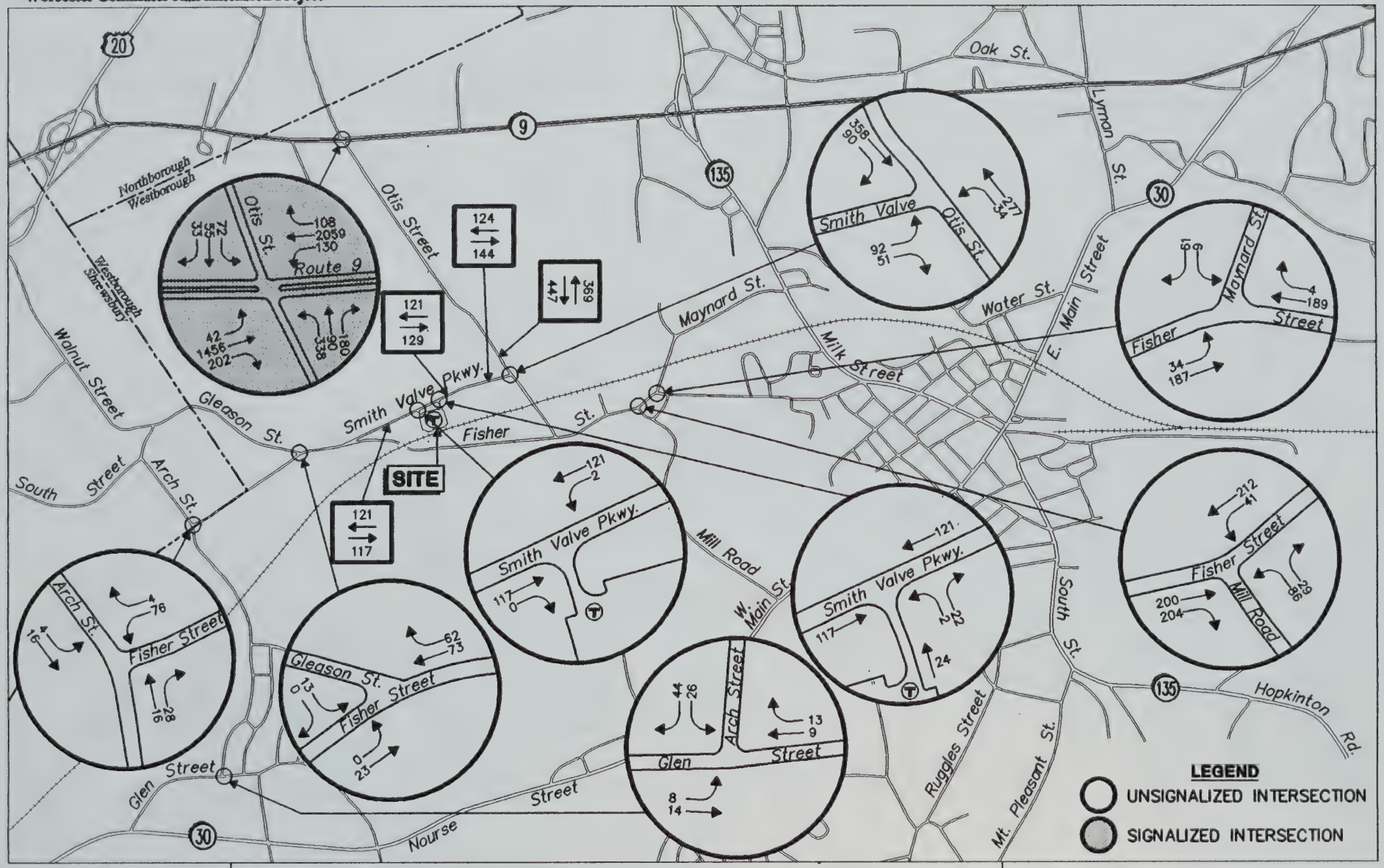
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-25



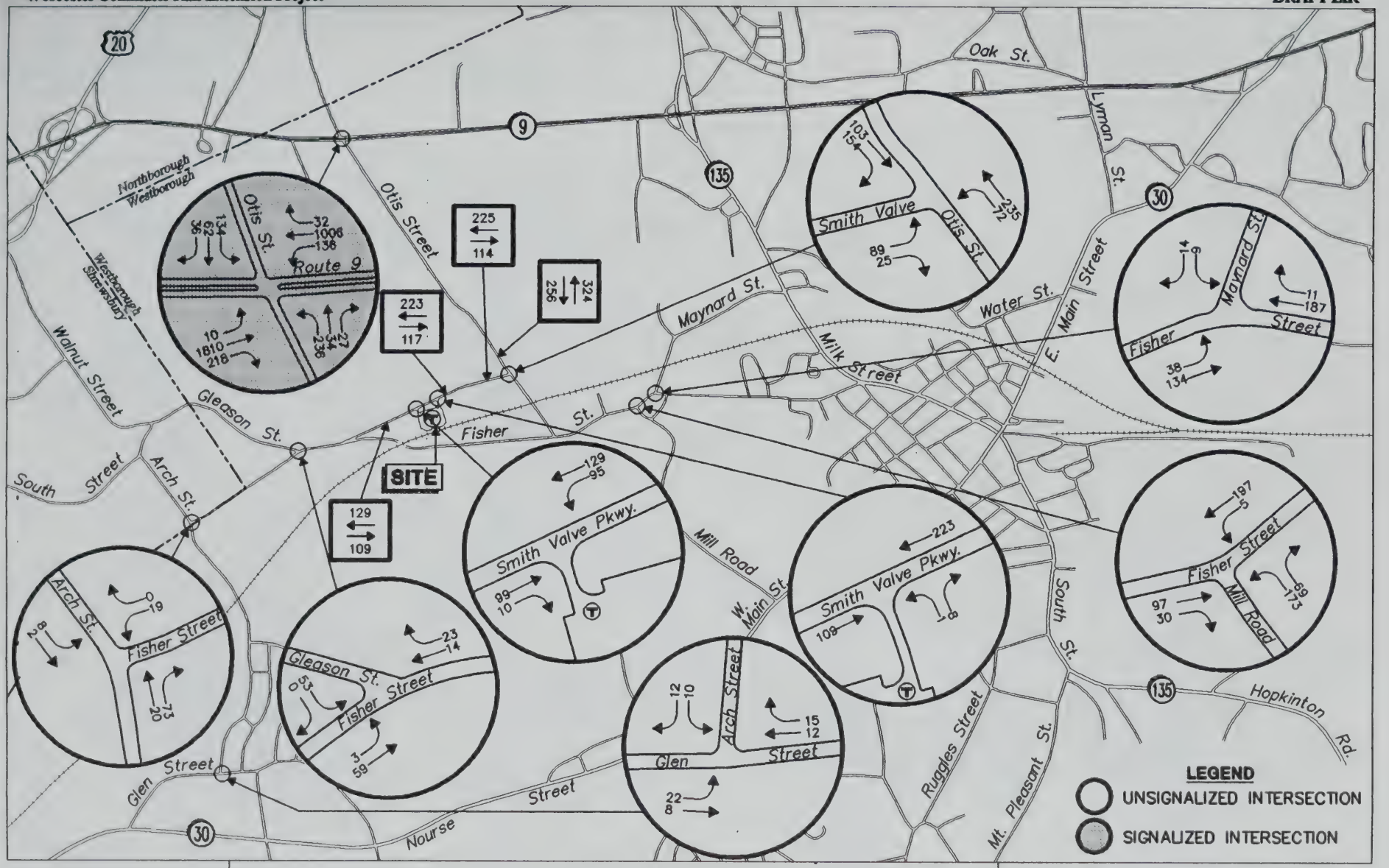
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'

0 2250

P.M. Peak Hour
4:45 - 5:45 P.M.
2001 BUILD ALL STATION
WESTBOROUGH STATION

FIGURE 1.6-26

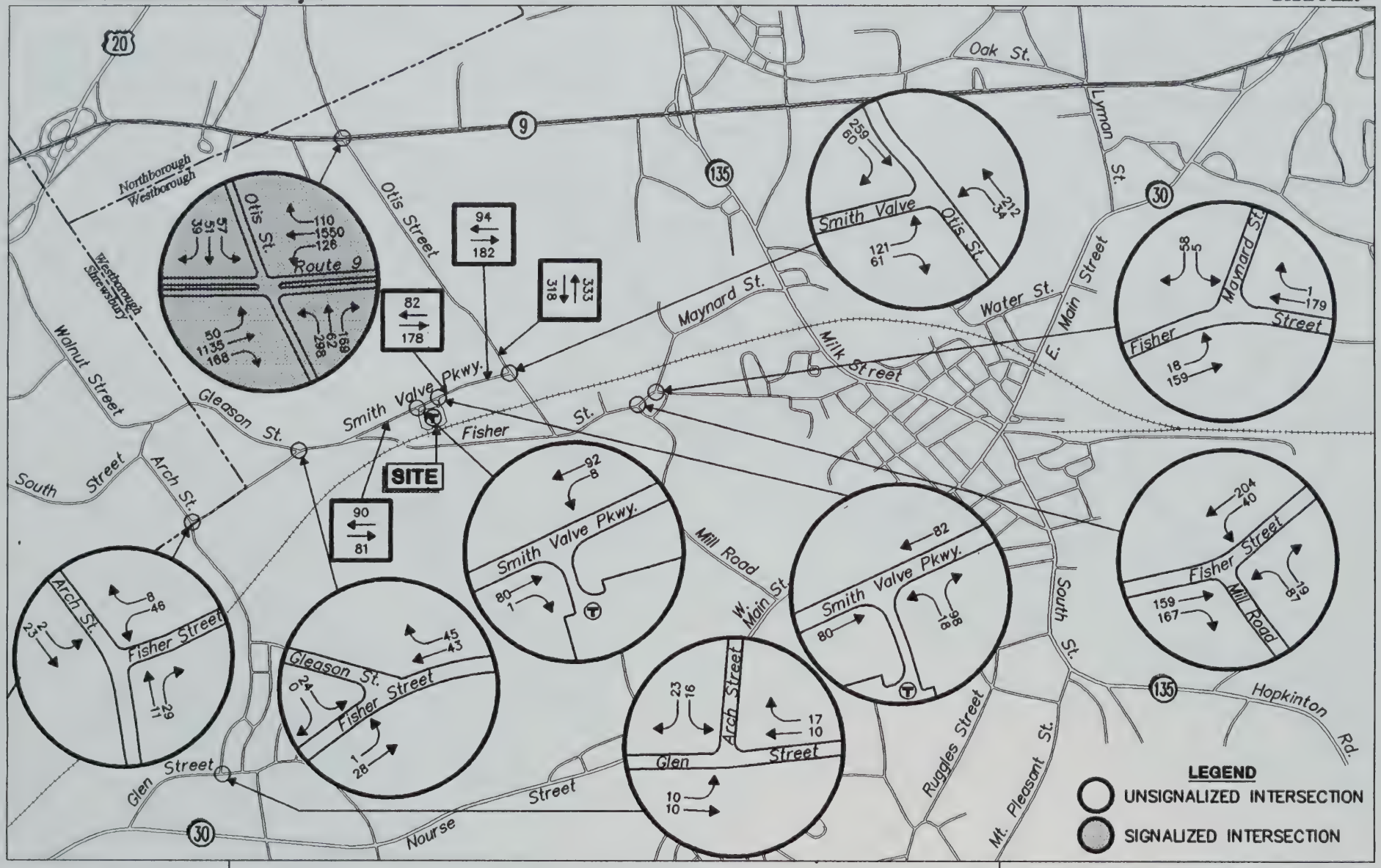


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
2001 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

P.M. Peak Generator Hour
5:45 - 6:45 P.M.
2001 BUILD ALL STATIONS
WESTBOROUGH STATION

FIGURE 1.6-28

Signalized Intersections

The signalized intersection was analyzed using the same methodology as in the existing conditions. Table 1.6-24 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 2001 "No Build" and "Build" conditions. The analysis was conducted utilizing the geometry proposed in the MHD intersection improvement project.

As shown in the table, the intersection and all individual movements will operate at acceptable levels of service under both the "No Build" and "Build" conditions.

No reduction in level of service at the intersection will occur as a result of traffic entering or existing the proposed commuter rail station.

Table 1.6-24 2001 Peak Hour Signalized Intersection Level of Service*

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis Street**	C(17.3)	C(16.8)	C(17.9)	C(17.0)
Eastbound	C(18.0)	B(14.5)	C(18.1)	B(14.5)
Westbound	B(9.8)	B(12.5)	B(11.2)	B(12.5)
Northbound	D(30.2)	D(36.8)	D(30.8)	D(38.0)
Southbound	D(32.6)	D(35.7)	D(33.6)	D(35.7)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Analysis based on proposed MHD geometry*
** *Optimized signal timings were used for analysis*

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis are listed in Table 1.6-25. Under the 2001 "No Build" conditions, all of the intersection movements would operate at an acceptable level of service. Under the 2001 "Build" conditions, all of the analyzed intersections would operate at acceptable levels of service.

Level of service would decline for traffic egressing Smith Valve Parkway onto Otis Street from LOS "B" to LOS "C" in the A.M. peak hour and from LOS "C" to LOS "D" in the P.M. peak hour.

Table 1.6-25 2001 Peak Hour Unsignalized Intersection Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1102)	A(994)	A(1101)	A(991)
LT and RT from Gleason	A(720)	A(697)	A(713)	A(696)
Smith Valve and Site's W-DW				
LT from WB Smith Valve	-	-	A(937)	A(1009)
Smith Valve and Site's E-DW				
LT from Lot	-	-	A(558)	A(596)
RT from Lot	-	-	A(899)	A(857)
Otis and Smith Valve				
LT from NB Otis	A(887)	A(671)	A(805)	A(669)
LT and RT from Smith Valve	B(328)	C(220)	C(280)	D(191)
Fisher and Mill				
LT from WB Fisher	A(969)	A(699)	A(966)	A(695)
LT and RT from Mill	B(369)	C(287)	B(337)	C(285)
Fisher and Maynard				
LT from EB Fisher	A(889)	A(897)	A(887)	A(897)
LT and RT from Maynard	A(598)	A(658)	A(602)	A(658)
Arch and Fisher				
LT from SB Arch	A(1102)	A(1145)	A(1102)	A(1145)
LT and RT from Fisher	A(877)	A(826)	A(877)	A(826)
Glen and Arch				
LT from EB Glen	A(1140)	A(1167)	A(1140)	A(1167)
LT and RT from Arch	A(926)	A(946)	A(926)	A(946)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.6-26 lists the results of this analysis for the A.M. and P.M. peak roadway hours.

As shown in the tables, all of the roadway segments analyzed would operate at acceptable levels of service under both the "No Build" and the "Build" conditions. No reductions in level of service will occur as the result of traffic entering or exiting the proposed station. The "Build" condition would result in minor reductions in reserve capacity for some segments.

Table 1.6-26 2001 Peak Hour Road Segment Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(1799)	D(1815)	C(1809)	D(1812)
Smith Valve West of Otis	B(2322)	B(2468)	B(2052)	B(2378)
Smith Valve West of Site	B(2338)	B(2477)	B(2339)	B(2459)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generator hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.6-27 for the 2001 "No Build" and "Build" conditions. The analysis was conducted utilizing the geometry proposed in the MHD intersection improvement plan.

As shown in the table, the intersection and all individual movements will operate at acceptable levels of service under both the "No Build" and "Build" conditions. A minor reduction in level of service, from LOS "B" to LOS "C," will occur during the A.M. peak generator hour.

Table 1.6-27 2001 Peak Generator Hour Signalized Intersection Level of Service*

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Route 9 and Otis Street**	B(14.9)	C(15.6)	C(15.6)	C(16.4)
Eastbound	B(14.7)	B(14.2)	B(14.7)	B(14.4)
Westbound	B(8.4)	B(12.8)	B(10.0)	B(12.9)
Northbound	D(32.8)	D(27.0)	D(33.5)	D(30.4)
Southbound	D(30.7)	D(28.7)	D(31.9)	D(29.0)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Analysis based on proposed MHD geometry*
** *Optimized signal timings were used for analysis*

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.6-28. Under the 2001 "No Build" conditions all of the analyzed intersections would operate at acceptable levels of service.

Under the 2001 "Build" conditions, the analyzed intersections would all operate at acceptable levels of service. A minor reduction in level of service will occur for traffic egressing Smith Valve Parkway to Otis Street in the P.M. peak generator hour.

Table 1.6-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Fisher and Gleason				
LT from EB Fisher	A(1098)	A(1050)	A(1097)	A(1041)
LT and RT from Gleason	A(707)	A(726)	A(698)	A(721)
Smith Valve and Site's W-DW				
LT from WB Smith Valve	-	-	A(920)	A(1042)
Smith Valve and Site's E-DW				
LT from Lot	-	-	A(516)	D(189)
RT from Lot	-	-	A(880)	A(822)
Otis and Smith Valve				
LT from NB Otis	A(894)	A(787)	A(802)	A(780)
LT and RT from Smith Valve	B(373)	B(372)	B(315)	C(249)
Fisher and Mill				
LT from WB Fisher	A(997)	A(789)	A(995)	A(764)
LT and RT from Mill	B(387)	B(337)	B(352)	B(324)
Fisher and Maynard				
LT from EB Fisher	A(889)	A(928)	A(887)	A(927)
LT and RT from Maynard	A(609)	A(711)	A(612)	A(711)
Arch and Fisher				
LT from SB Arch	A(1086)	A(1152)	A(1086)	A(1152)
LT and RT from Fisher	A(858)	A(868)	A(858)	A(868)
Glen and Arch				
LT from EB Glen	A(1147)	A(1159)	A(1147)	A(1159)
LT and RT from Arch	A(966)	A(967)	A(966)	A(967)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.6-29 lists the results of this analysis for the A.M. and P.M. peak generator hours.

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service under both the "No Build" and "Build" conditions. Smith Valve Parkway west of Otis Street would experience a reduction in level of service from LOS "B" to LOS "C" in the A.M. generator hour. Levels of service for the other segments would remain the same, with some reductions in reserve capacity in the "Build" condition.

Table 1.6-29 2001 Peak Generator Hour Road Segment Level of Service

Westborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Otis North of Smith Valve	C(2009)	C(2082)	C(2042)	C(2048)
Smith Valve West of Otis	B(2270)	B(2504)	C(2004)	B(2164)
Smith Valve West of Site	B(2260)	B(2510)	B(2280)	B(2471)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.6-30 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. roadway and peak generator hours.

As shown in Table 1.6-30, and intersection other than the two site driveways, would receive 10 percent or more of its traffic from the proposed rail station during the A.M. or P.M. peak roadway hours. The intersection of Otis Street and Smith Valve Parkway would see 12.7% of its traffic be site related in the A.M. peak hour.

Two roadway segments would receive over 10 percent of their traffic from the proposed rail station; Otis Street, north of Smith Valve Parkway and Smith Valve Parkway west of Otis Street.

Table 1.6-30 2001 "Build" Condition - 10% Analysis

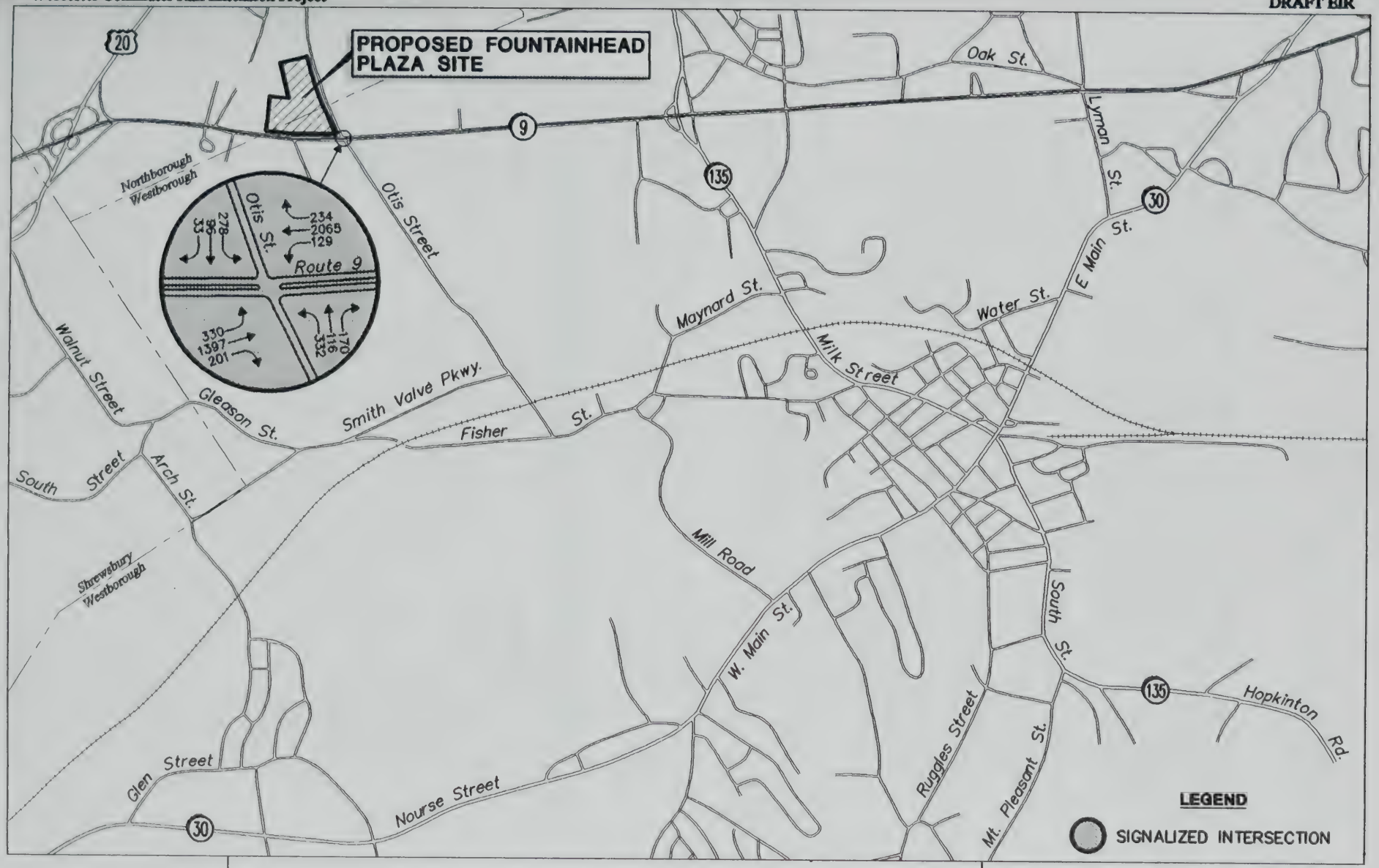
Intersection	Peak Hours	
	A.M.	P.M.
Fisher and Gleason	7.3%	1.2%
Smith Valve and Site's West DW	32.5%	1.7%
Smith Valve and Site's East DW	32.1%	9.2%
Otis and Smith Valve Parkway	12.7%	2.7%
Fisher and Mill	4.4%	0.7%
Fisher and Maynard	0.8%	0.0%
Route 9 and Otis	1.6%	0.4%
Arch and Fisher	1.9%	0.0%
Glen and Arch	2.3%	0.0%
Roadway Segment		
Smith Valve West of Site	4.8%	0.8%
Smith Valve West of Otis	30.7%	9.0%
Otis North of Smith Valve	10.4%	2.4%

Site generated traffic as a percentage of total traffic

Fountainhead Plaza

As previously mentioned, there is a large site specific project still in the planning process in the vicinity of the Westborough Commuter Rail Station. The project is called Fountainhead Plaza. If developed as currently envisioned this project will bring 144,000 square feet of retail space to the northwest corner of the intersection of Route 9 with Otis Street. The level of service ratings for intersection of Route 9 with Otis Street with the expected traffic from the Fountainhead Plaza project can be found in Table 1.6-31.

Using the "Build" site traffic data developed in the Fountainhead Plaza from EOEA #6802 for the P.M. peak hour and the previously developed "No Build" volumes for the P.M. peak hour in the year 2001, a revised "No Build" year 2001 condition was established. Figure 1.6-29 shows the revised P.M. peak hour traffic volume for the Route 9 with Otis Street intersection for the year 2001 "No Build" condition.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

P.M. Peak Hour 4:45-5:45 P.M.
Fountainhead Plaza Option
2001 NO BUILD
WESTBOROUGH STATION

FIGURE 1.6-29

The analysis of the revised year 2001 "No Build" condition was performed with the improvements to the northern leg of Otis Street planned to be installed by the developer of the Fountainhead Plaza. The analysis showed the intersection of Route 9 with Otis Street to be at a level of service rating of "D" in the P.M. peak hour of the year 2001. The results of the analysis can be found in Table 1.6-31.

The northbound approach will operate at LOS "F" while the southbound approach will operate at LOS "E".

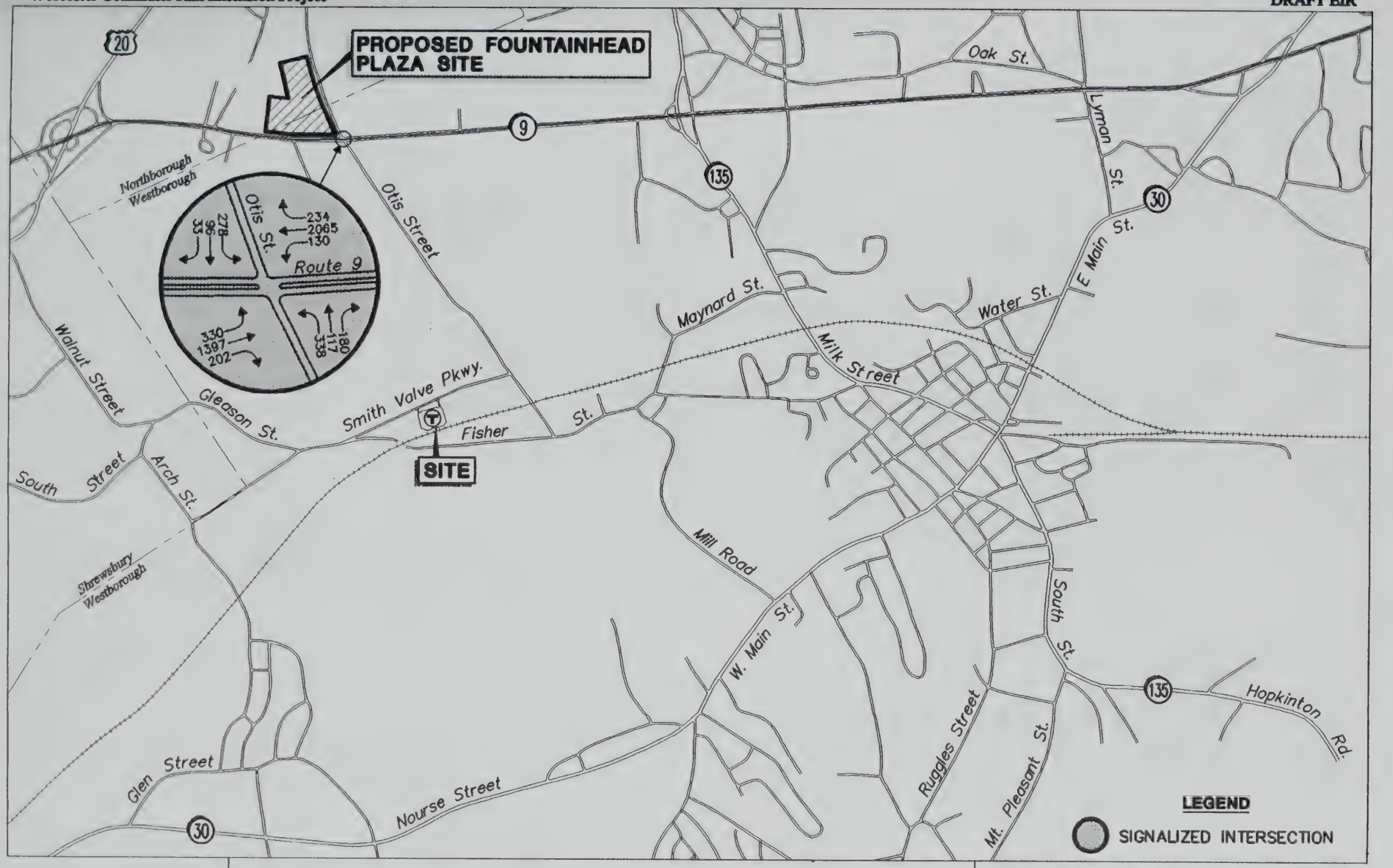
The P.M. peak hour traffic projected to be at the intersection of Route 9 with Otis Street from the commuter rail station was added to the revised "No Build" traffic volumes to create the revised "Build" condition for the year 2001. Figure 1.6-30 shows the revised P.M. peak hour traffic volumes for the Route 9 with Otis Street intersection for the year 2001.

The analysis of the "Build" condition for the year 2001 showed the intersection of Route 9 with Otis Street to be at a level of service rating of "D" in the P.M. peak hour. The northbound and southbound approaches will operate at LOS "F" and "E", respectively.

Comparison of the "No Build" analysis to the "Build" analysis for the year 2001 shows the traffic from the commuter rail station is not significantly affecting the operation of the intersection of Route 9 with Otis Street on the P.M. peak hour.

Table 1.6-31 2001 Peak Hour Signalized Intersection Level of Service

Westborough	No Build	Build
Route 9 and Otis Street	D(39.2)	D(39.8)
Eastbound	D(29.0)	D(29.0)
Westbound	D(36.2)	D(36.2)
Northbound	F(77.4)	F(81.6)
Southbound	E(53.1)	E(53.4)



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 2250'
0 2250

P.M. Peak Hour 4:45-5:45 P.M.
Fountainhead Plaza Option
2001 BUILD
WESTBOROUGH STATION

FIGURE 1.6-30

Summary of Findings

The basic findings of the traffic analysis were that all of the streets and intersections studied in Westborough are currently operating well with the exception of Route 9 at Otis Street. Geometric improvements proposed by the Massachusetts Highway Department will help to improve traffic flow at this intersection. It is expected that these improvements will be in place by 1996. The addition of the proposed commuter rail station on Smith Valve Parkway would attract a projected ridership of 230 patrons by the year 2001. The analysis performed indicates that the level of service of the streets and intersections in the vicinity of the proposed station will not be seriously impacted by construction of the commuter rail station.

1.7 Southborough Station

Project Introduction

The proposed Southborough Commuter Rail Station is to be constructed off of Southville Road just west of River Street (Route 85) on the Southborough/Hopkinton town line. Access will be gained from Southville Road or River Street. The station will primarily serve the communities of Hopkinton, Marlborough, Southborough, Upton, and Westborough.

The proposed site is located in two parcels, one to the north and one to the south of the existing tracks. The portion of the site north of the tracks is currently occupied by a convenience/general store. The existing parking lot for the store is not well defined, but it has been assumed that the store and its associated parking will remain on the east side of this parcel. The portion of the site that lies to the south of the tracks is located on the former site of a woolen mill and a fenced in contractor storage yard.

The site was selected by the MBTA and a citizen committee established by the Southborough Board of Selectmen after a review of several potential sites. This location was chosen based on its potential parking capacity, availability of vacant land, proximity to major access roadways, joint development potential and the minimal potential for environmental and neighborhood impacts.

The proposed station is comprised of two parking lots, with 90 parking spaces located in a lot north of the tracks and 330 parking spaces located in a lot south of the tracks, for a total of 420 parking spaces. Station facilities will also include: two 800 foot long low level platforms, two 45 foot long mini-high platforms for handicapped access, a pedestrian overpass, a drop off area for Kiss'n'Ride patrons in each parking lot, adequate lighting for public safety, and landscaping.

Study Area

The study area for assessment of traffic impacts at this station is focused on roadways which are anticipated to be used as the major access routes. These roadways include:

- Route 9
- Cordaville Road (Route 85)
- Southville Road
- Woodland Road
- River Street

The roadways within the study area are maintained by the Town of Southborough with the exceptions of the Boston-Worcester Turnpike (Route 9) and the portion of Southville Road which lies between Woodbury Road and the Ashland town line.

With the exception of Route 9, most of these roadways are two lane facilities with at-grade intersections controlled by stop signs and/or traffic signals. These roadways serve a mixture of light industrial, commercial, retail and residential land uses. There are no designated truck routes within the study area. However, there are height and/or weight restrictions on several study area roadways including:

- Marlborough Road
- Northborough Road
- Central Street
- White Bagley Road
- Route 85 (River Street)
- Willow Street

Truck traffic is prohibited completely on Chestnut Hill Road.

Major commuter routes in the Southborough area generally include those routes that lead to the Massachusetts Turnpike at Interchange 12 in Framingham. These routes include: Route 9, Framingham Road, Boston Road (Route 30) and Route 85.

Data Collection

To assess the existing transportation environment, a data collection program was begun in September 1992, and completed in May, 1993. Data items necessary for analysis of operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing and timing, and geometric configuration of roadway links and intersections.

The turning movement counts used to obtain the traffic volumes used in the level of service analysis were made at the following intersection on the dates shown below:

	A.M.	P.M.
Route 9 EB Ramps with Route 85 NB	6-2-93	6-2-93
Route 9 WB Ramps with Route 85 NB	6-2-93	6-2-93
Cordaville Road with Southville Road	9-29-92	9-17-92
Cordaville Road with River Street	9-30-92	9-21-92
Cordaville Road with Woodland Road	11-24-92	11-18-92
Southville Road with River Street	9-24-92	9-16-92
Cordaville Road with Main Street	4-13-94	4-13-94

Vehicle turning movements at these intersections were observed and recorded from 6:15 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the roadway peak hour volumes, and the volumes during the projected commuter rail station peak generator hours.

The field data sheets for the counts are included in an uncirculated appendix available for review at the MBTA and MEPA office.

Vehicles were classified into two categories: cars and trucks or buses. Volumes were recorded in 15 minute intervals to allow determination of the true peak hour, and calculation of peak hour factors. The 1992 peak hour traffic volumes are shown on Figures 1.7-1 and 1.7-2 for the A.M. and P.M. peak hours respectively. Since peak generator hours for the station's traffic may not coincide with standard peak hours, it is also necessary to analyze the A.M. and P.M. peak generator hours. The 1992 site peak generator hours are shown on Figures 1.7-3 and 1.7-4 for the A.M. and P.M. peak hours respectively.

Traffic signal timing is required for analysis of intersection operations. Traffic signal phasing and timing, where applicable, were obtained from the Town of Southborough Highway Department.

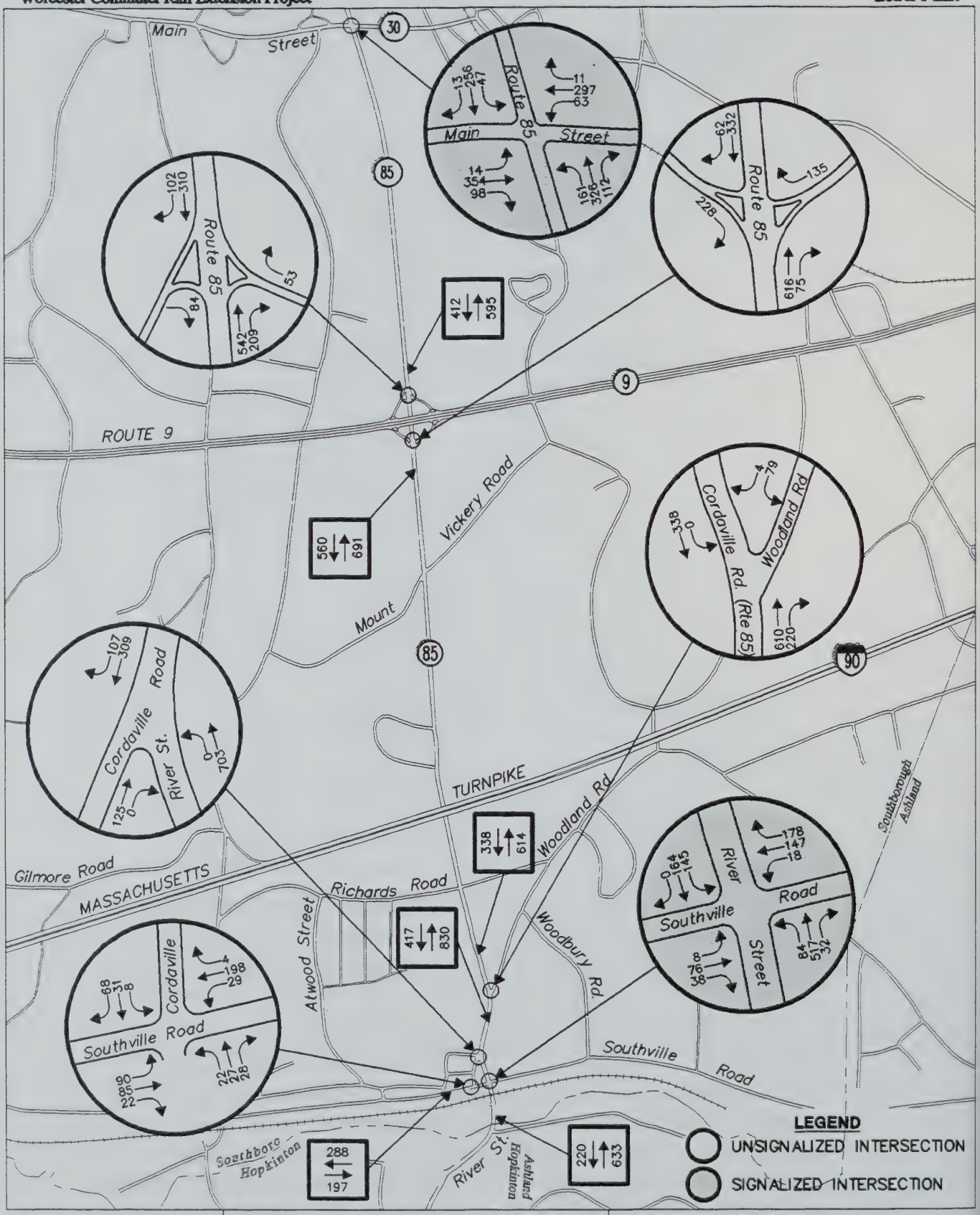
Geometric elements such as number and use of travel lanes, lane widths, and roadway grades are required for analysis of operational conditions and were observed in the field.

Year 1992 Existing Conditions

Signalized Intersections

The existing signalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The micro-computer software package "CINCH", developed by Central Transportation Planning Staff (CTPS) was used for the intersection analysis. This program automates the analysis procedures of the HCM. The computerized outputs of "CINCH" can be found in a report available at the MBTA and MEPA.

The analysis is based on various parameters such as intersection geometrics, traffic volumes and movements, traffic signal timing, vehicle mix, etc. The average length of time that a vehicle is sitting stationary at the intersection, known as average vehicle stopped delay, is determined and used to categorize the level of service



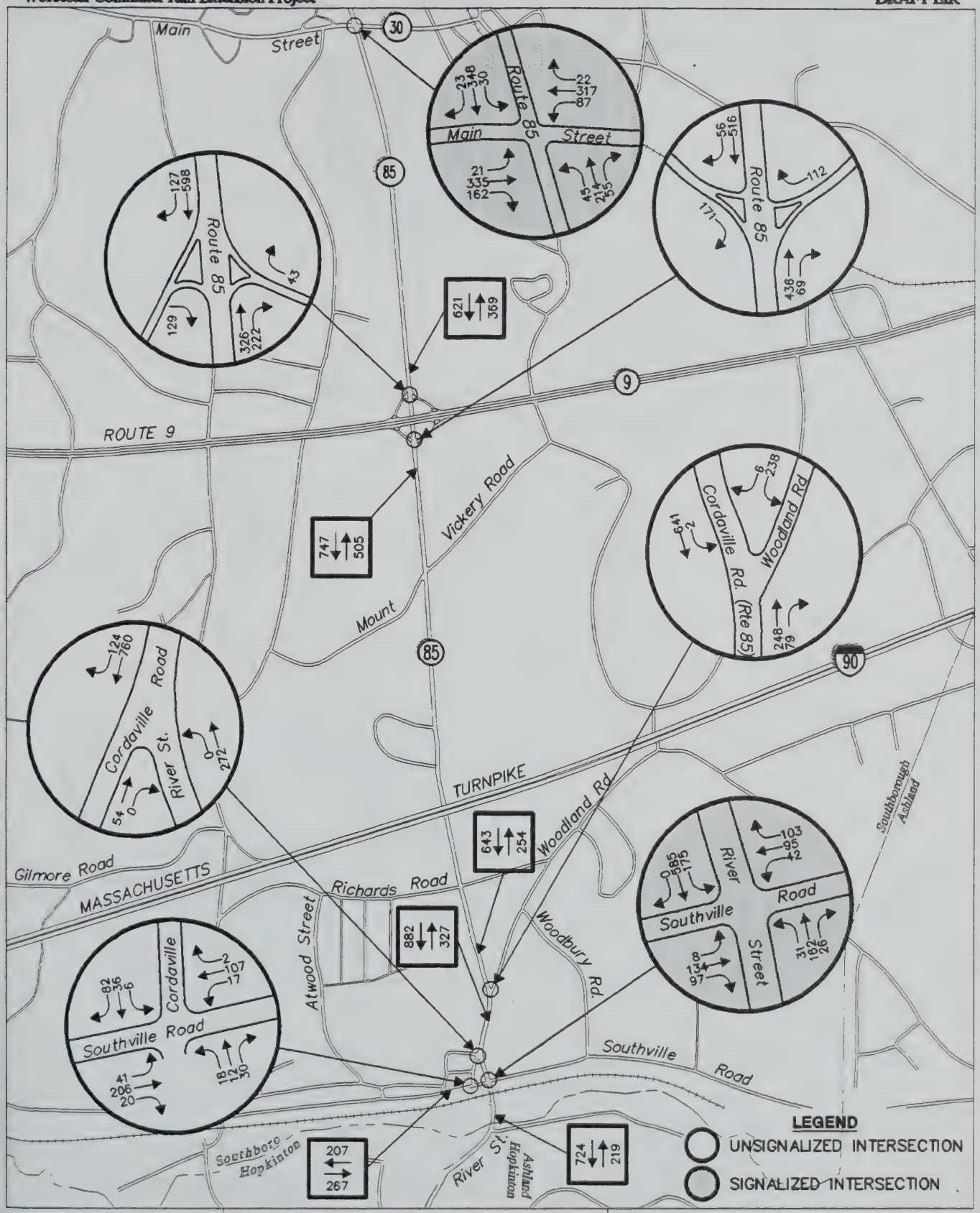
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
1992 Existing Conditions
SOUTHBOROUGH STATION

FIGURE 1.7-1



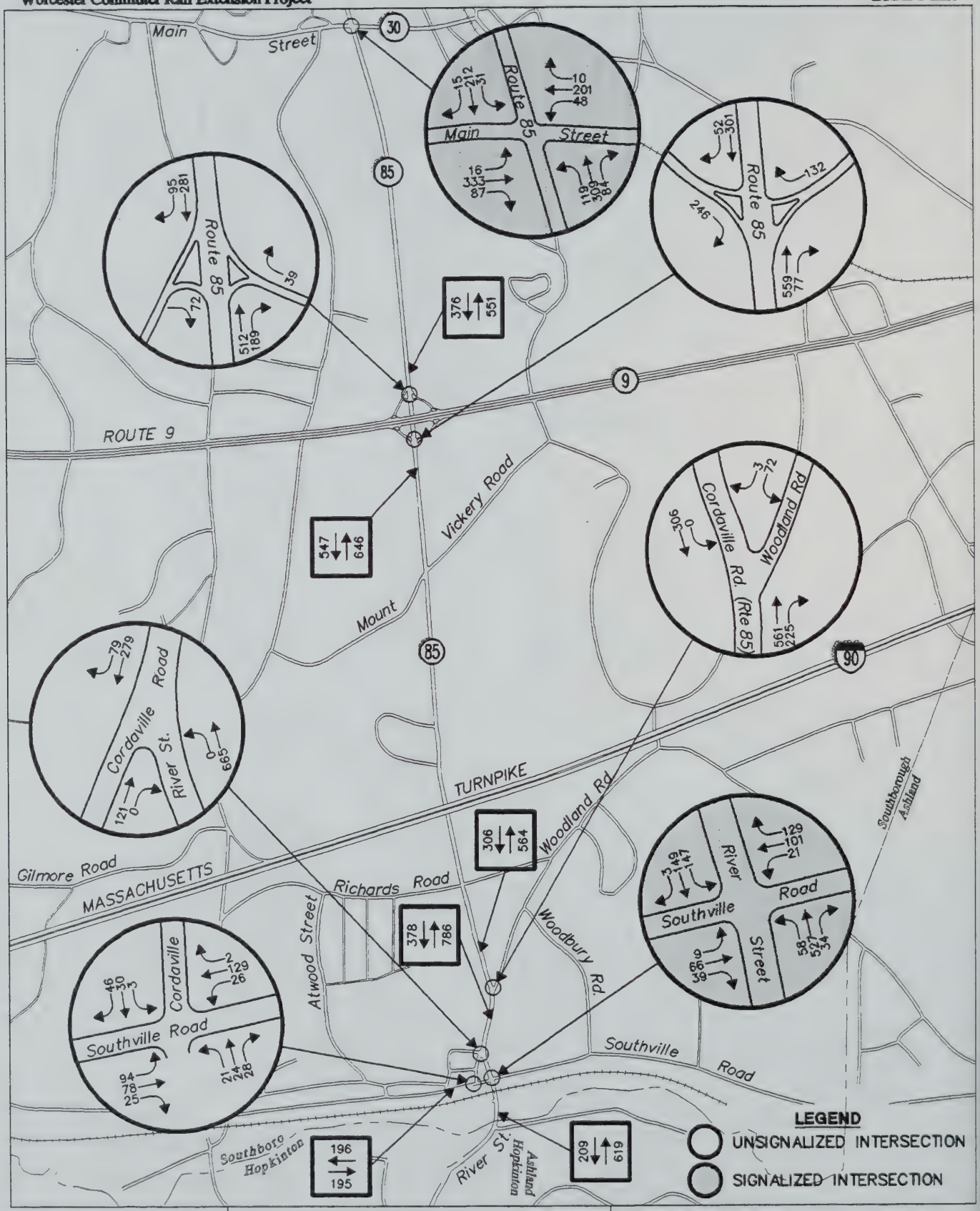
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1992 Existing Conditions
SOUTHBOROUGH STATION

FIGURE 1.7-2

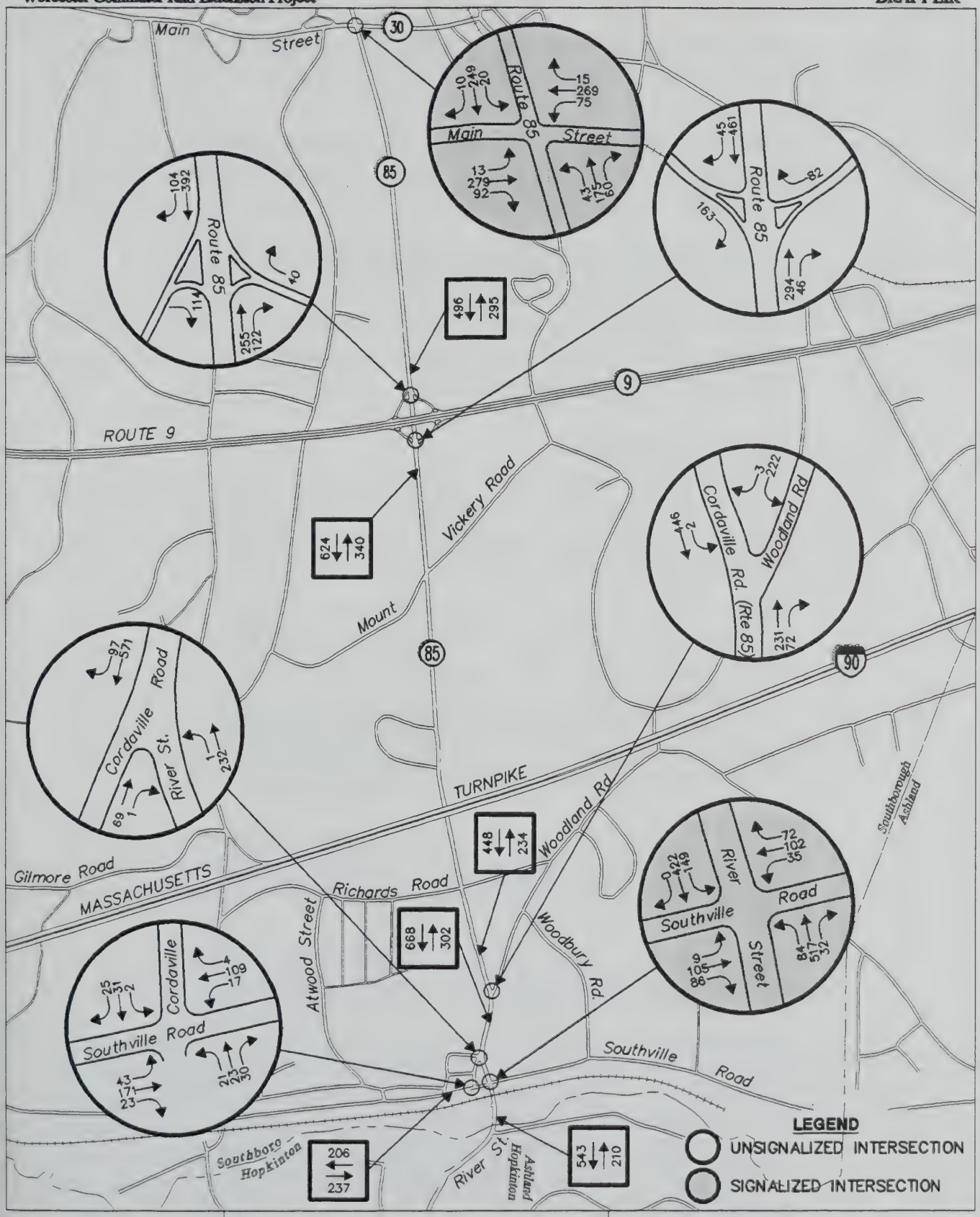


Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
1992 Existing Conditions
SOUTHBOROUGH STATION

FIGURE 1.7-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1992 Existing Conditions
SOUTHBOROUGH STATION

FIGURE 1.7-4

(LOS) of the intersection. LOS ranges from a virtual free flowing condition "A", to congestion and high stopped delays "F". A detailed description of level of service is presented in Section 1.1 of this report. Two signalized intersections were analyzed:

River Street/Southville Road Intersection

Southville Road intersects River Street (Route 85) at a 90 degree angle forming a cross road intersection. The intersection is just to the north of the Conrail tracks. Both roads are two lane collector roads. Traffic is controlled by a traffic actuated signal. There are no additional intersection lanes.

Cordaville Road/Main Street

Main Street (Route 30) intersects Cordaville Road (Route 85) at a 90 degree angle forming a cross road intersection. The intersection is located north of Route 9. Both roads are two lane collector roads. Traffic is controlled by a traffic actuated signal. There are no additional intersection turning lanes.

Table 1.7-1 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours. Signalized intersections may be assigned an overall LOS rating as well as on individual approaches. As shown in the table, the Southville Road/River Street intersection operates at an unacceptable level of service (LOS "F") in the A.M. peak hour. The northbound and southbound approaches of River Road at Southville Road operate at a LOS "F" during the A.M. peak hour. During the P.M. peak hour, only the southbound approach operates at an unacceptable LOS "F".

The intersection of Cordaville Road and Main Street operates at acceptable overall level of service ratings in both the A.M. and P.M. peak hours. Only the northbound approach operates at an unacceptable level of service (LOS "F") during the A.M. peak hour.

Analysis was also performed for the site peak generator hours, (i.e., the hours when the highest traffic volumes entering and exiting the site will occur).

The results of the A.M. and P.M. peak generator hour analyses are also included in Table 1.7-1. The table shows the overall LOS rating for the intersection as well as each movement, and the average vehicle stopped delay, in seconds. The Southville Road/River Street intersection operates at an unacceptable overall level of service during the A.M. peak generator hour. The northbound and southbound approaches of River Street at Southville Road operate at a LOS "F" during the A.M. peak generator hour. During the P.M. peak generator hour, the southbound approach operates at LOS "E".

The Cordaville Road/Main Street intersection operates at acceptable levels of service during both the A.M. peak generator hour and the P.M. peak generator hour. The northbound approach in the A.M. peak generator hour operates at LOS "E".

Table 1.7-1 1992 Existing Signalized Intersection Level of Service

Southborough	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	E(56.4)	F*	D(25.0)
Eastbound	B(9.1)	B(10.2)	B(9.1)	B(9.6)
Westbound	B(11.8)	B(10.5)	B(10.5)	B(10.1)
Northbound	F(76.4)	C(18.0)	F(63.5)	B(11.9)
Southbound	F*	F(99.2)	F*	E(40.0)
Cordaville and Main	D(32.6)	C(18.1)	D(27.0)	B(13.0)
Eastbound	B(14.0)	C(15.9)	B(14.0)	B(12.8)
Westbound	C(15.8)	D(31.7)	C(16.3)	C(16.8)
Northbound	F(70.8)	B(11.6)	E(54.4)	B(10.7)
Southbound	B(13.6)	B(11.7)	B(12.3)	B(10.4)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the 1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM). The software program "CINCH" was used to perform the analysis. The computerized outputs of "CINCH" can be found in a report available at the MBTA and MEPA. As with the signalized intersections, A.M. and P.M. analyses were performed for both the intersection peak hour and the site peak generator hour.

As opposed to the signalized intersection results, levels of service for unsignalized intersections are stated in terms of reserve capacity for a particular movement only. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. A detailed description of level of service is provided in Section 1.1 of this report.

Southville Road/Cordaville Road Intersection

Cordaville Road intersects Southville Road at approximately 90 degrees forming a "T" intersection. Opposite the Cordaville Road approach is the driveway to a general store. The intersection is just to the north of the Conrail tracks. Both roads are two lane collector roads. The southbound Cordaville traffic is controlled by a stop sign. The left turning, right turning, and through movements are in a shared lane.

Cordaville Road/River Street Intersection

River Street intersects Cordaville Road at an angle forming a "Y" intersection. Both roadways are two lane collector roads. The southern leg of Cordaville Road is the minor approach and its traffic is controlled by a stop sign. The northern leg of Cordaville Road and the other southern leg of River Street are the major legs and are designated as Route 85.

Cordaville Road/Woodland Road Intersection

Woodland Road intersects Cordaville Road (Route 85) at an angle forming a "Y" intersection. Both roads are two lane collector roads. The southbound Woodland Road traffic turning left or right is on a shared lane and is controlled from accessing Cordaville Road by a stop sign.

Route 9/Cordaville Road Interchange

Cordaville Road (Route 85) crosses over Route 9. The roadways are connected by a modified clover leaf interchange. Turning traffic is limited to right turns only but access is controlled by a stop sign. There are no acceleration lanes to allow traffic to merge. The ramps are two lane roads with directional travel separated only by a double yellow center line.

Results of the A.M. and P.M. peak hour analysis for the unsignalized intersection are listed in Table 1.7-2. The table shows the LOS ratings as well as the reserve capacity, in vehicles, for each intersection movement. Unlike signalized intersections, only individual movements are assigned a level of service rating. The intersection cannot be assigned an overall rating. As shown in the table, most of the analyzed intersection movements operate at acceptable levels of service. During the A.M. and P.M. roadway peak hours, the left and right turn movements from Cordaville Road onto River Road operate at a LOS "E". The left and right turn movements from Woodland Road onto Cordaville Road also operate at a LOS "E" and LOS "F" during the A.M. and P.M. peak hours, respectively.

Results of the A.M. and P.M. peak generator hour analyses are also listed in Table 1.7-2. As shown in the table, all of the unsignalized intersections operate at acceptable levels of service. The left and right turn movements from Cordaville Road onto River Street operate at a LOS "E" during the A.M. peak hour. The left and right turn movements from Woodland Road onto Cordaville Road also operate at a LOS "E" during both the A.M. and P.M. peak hours.

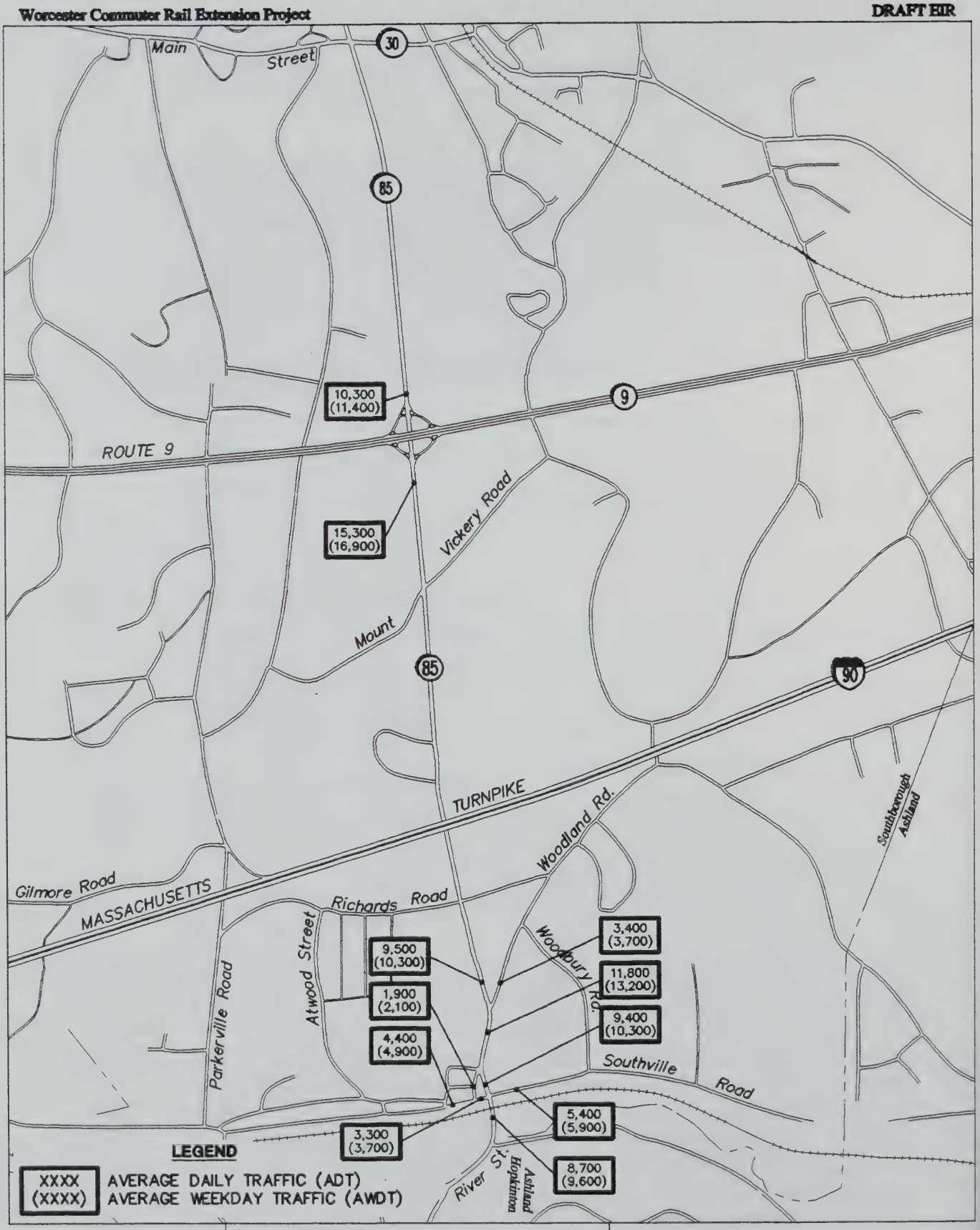
Table 1.7-2 1992 Existing Unsignalized Intersection Level of Service

Southborough	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Southville and Cordaville				
LT from EB Southville	A(848)	A(997)	A(919)	A(991)
LT from WB Southville	A(1011)	A(900)	A(1018)	A(932)
All from Store	A(441)	A(498)	A(519)	A(505)
All from Cordaville	A(524)	A(607)	A(614)	A(675)
Cordaville and River				
LT from NB River	A(762)	A(412)	A(758)	A(538)
LT and RT from Cordaville	E(19)	E(84)	E(42)	D(148)
Cordaville and Woodland				
LT from SB Cordaville	A(441)	A(801)	A(466)	A(823)
LT and RT from Woodland	E(66)	F(-55)	E(99)	E(53)
NB Cordaville and EB Ramps				
RT from EB Route 9 Ramp	B(361)	A(514)	B(394)	A(675)
SB Cordaville and EB Ramps				
RT from EB Route 9 Ramps	A(490)	B(335)	A(493)	A(453)
NB Cordaville and WB Ramps				
RT from WB Route 9 Ramp	A(453)	A(615)	A(493)	A(720)
SB Cordaville and WB Ramps				
RT from WB Route 9 Ramp	A(633)	A(434)	A(676)	A(536)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The average daily traffic (ADT) and average weekday traffic (AWDT) was collected for several streets in the downtown section of Southborough. Figure 1.7-5 presents



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

1992 Average Daily Traffic & 1992 Average Weekday Traffic SOUTHBOROUGH, MA

FIGURE 1.7-5

the 1992 ADT and AWDT volumes for several streets showing the relative 24 hour volumes of traffic that use these streets.

Several roadway segments were analyzed for level of service. These segments were analyzed using the procedures set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The software program "Highway Capacity Software" (HCS) was used to perform the analysis. The computerized outputs from "HCS" can be found in an uncirculated report available at the MBTA and MEPA. As with the intersection analysis, both the A.M. and P.M. roadway and peak site generator hours were analyzed. Table 1.7-3 lists the results of this analysis for the A.M. and P.M. peak hours, and the A.M. and P.M. peak generator hours.

As shown in the table, most of the roadway segments operate at acceptable levels of service during the A.M. and P.M. peak roadway hour. Even though Cordaville Road north and south of Route 9, north of Woodland Road and north of River Road are shown to operate at a LOS "E", there is still sufficient reserve capacity to accommodate more than 800 additional peak hour vehicles before reaching capacity.

Table 1.7-3 also lists the results of the analysis for the A.M. and P.M. peak generator hours. As shown in the table, all of the roadway segments operate at acceptable levels of service during the A.M. and P.M. peak generator hour. Even though Cordaville Road south of Route 9, and north of River Road are shown to operate at a LOS "E", there is still sufficient reserve capacity to accommodate at least 915 additional peak hour vehicles before reaching capacity.

Table 1.7-3 1992 Existing Road Segment Level of Service

Southborough	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
River South of Site	D(1196)	E(1055)	D(1167)	D(1324)
Southville West of Site	C(1687)	C(1831)	C(1915)	C(1909)
Cordaville North of River	E(817)	E(820)	E(915)	E(1119)
Cordaville North of Woodland	E(1177)	E(1156)	D(1254)	D(1457)
Cordaville South of Route 9	E(945)	E(939)	E(1043)	E(1173)
Cordaville North of Route 9	E(1137)	E(1170)	D(1223)	D(1384)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Safety Concerns and Accident History

The Southborough Police Department was contacted on June 22, 1994 to ascertain the existence and location of any high frequency accident locations or safety concerns. Chief Colleary indicated that there were no high frequency accident locations within the study area. However, he did express concerns regarding safety and traffic flow at several locations. These concerns are discussed in Southborough Station Mitigation Section of this DEIR.

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

Year 1996 "No Build" Traffic Volumes

The year 1996 "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments proximate to the study area.
- Increases in existing traffic volumes due to population growth and development proximate to, but outside of the study area.

Through discussions with the Town of Southborough,it was determined that no new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of 1996 "No Build" condition traffic.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. Seven count sites for this data are located within the study area in Southborough. Based upon the data from these seven locations, the traffic volume growth rate was found to be extremely low. Growth rates at these locations ranged from positive 4.0% to negative 3.5%, with an average growth rate of 0.3%. A location along Route 9 east of I-495 showed an average rate of -2.5% over the last six years.

This relatively low growth rate may be due to the economic downturn experienced throughout the nation over the past years. Economic indicators point towards a

recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

To account for this potential growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5% per year was applied to the 1992 existing condition traffic volumes. Figures 1.7-6 and 1.7-7 show the A.M. and P.M. peak hour traffic volumes respectively. Figures 1.7-8 and 1.7-9 show the A.M. and P.M. peak generator hour volumes.

The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail to Worcester.

Year 1996 Trip Generation/Parking

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011 a total of 2,701 persons are expected to utilize the railroad for daily round trip commutation into Boston.

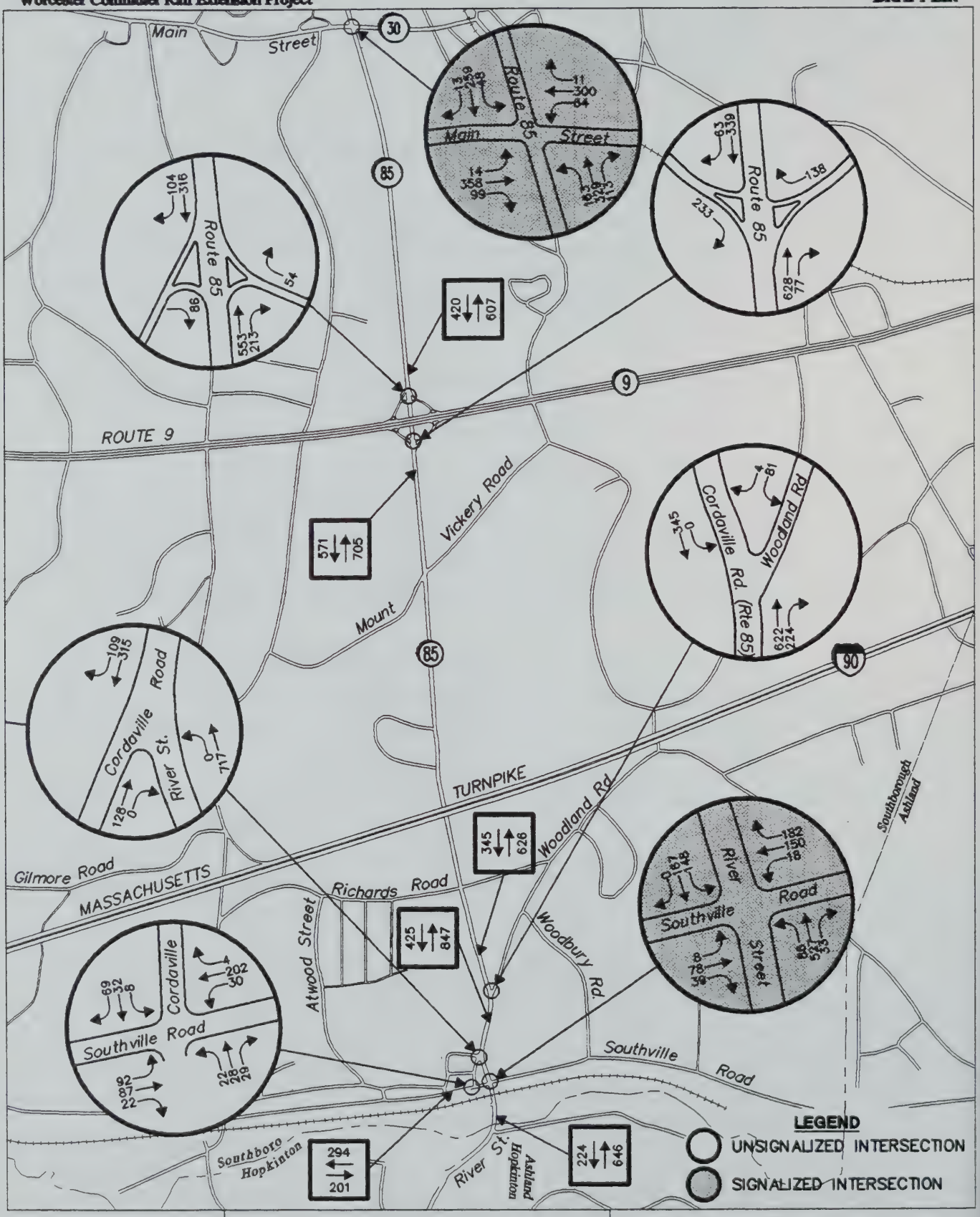
By 1996, the proposed Southborough Station is projected to attract a total of 550 daily round trip commuters. A total of 83 of these commuters would be dropped off at the station. Based upon an average automobile occupancy rate of 1.12, the approximately 467 Park'n'Ride patrons would result in a parking demand of 420 spaces. This is the capacity of the proposed parking lot.

These patrons are projected to reside in the Towns of Hopkinton, Marlborough, Southborough, Upton and Westborough. Due to the stations proposed location, no riders are projected to walk to the station. The number of patrons who originate from each Town are shown in Table 1.7-4. The ridership has been revised to reflect peak period usage which is 94% of total daily demand.

Table 1.7-4 Projected Patrons of Southborough Station Year 1996

Town	Riders*
Hopkinton	86
Marlborough	214
Southborough	85
Upton	75
Westborough	56
TOTAL	**516**

* *Adjusted for peak period demand*



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
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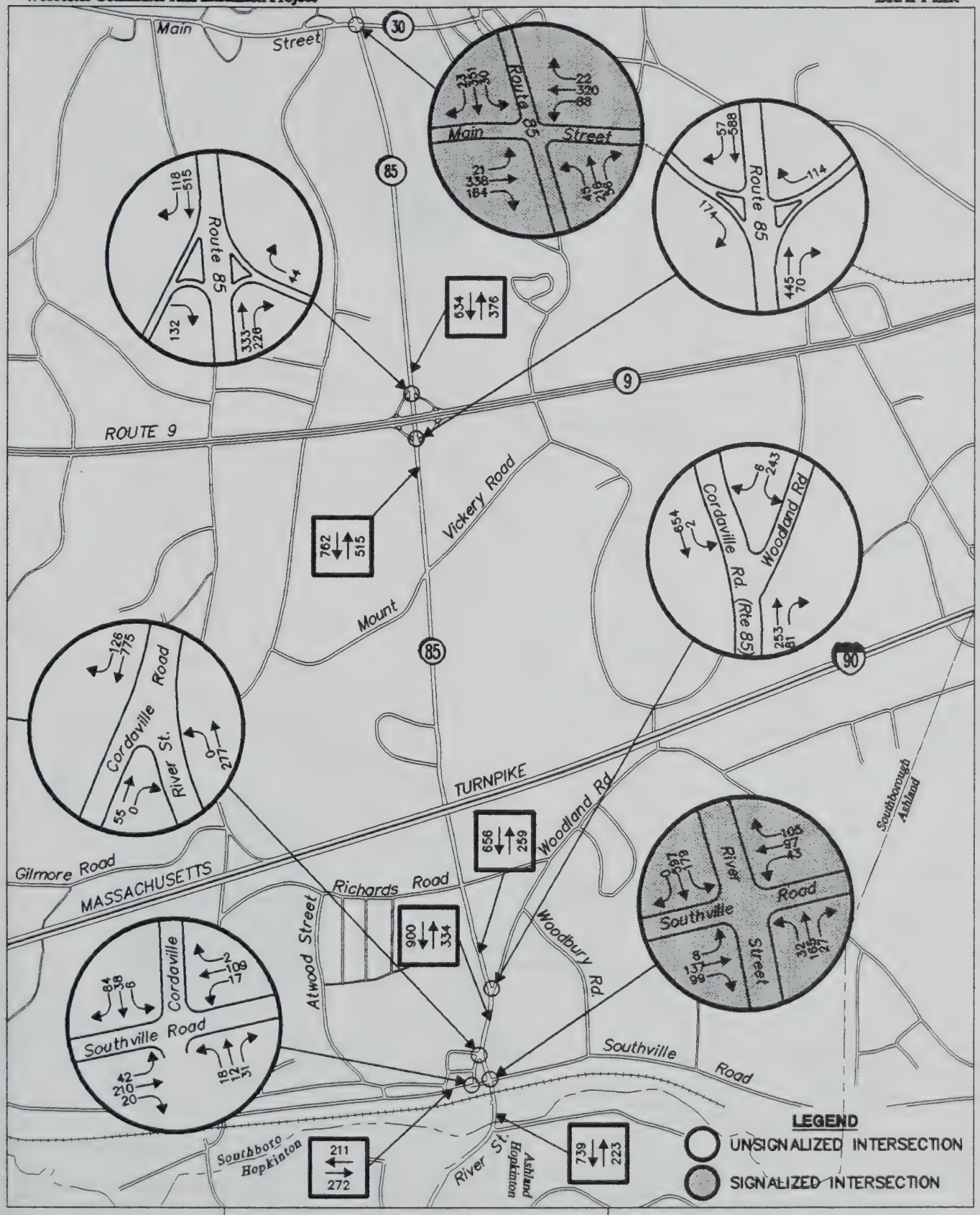
A.M. Peak Hour
7:30 - 8:30 A.M.
1996 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-6



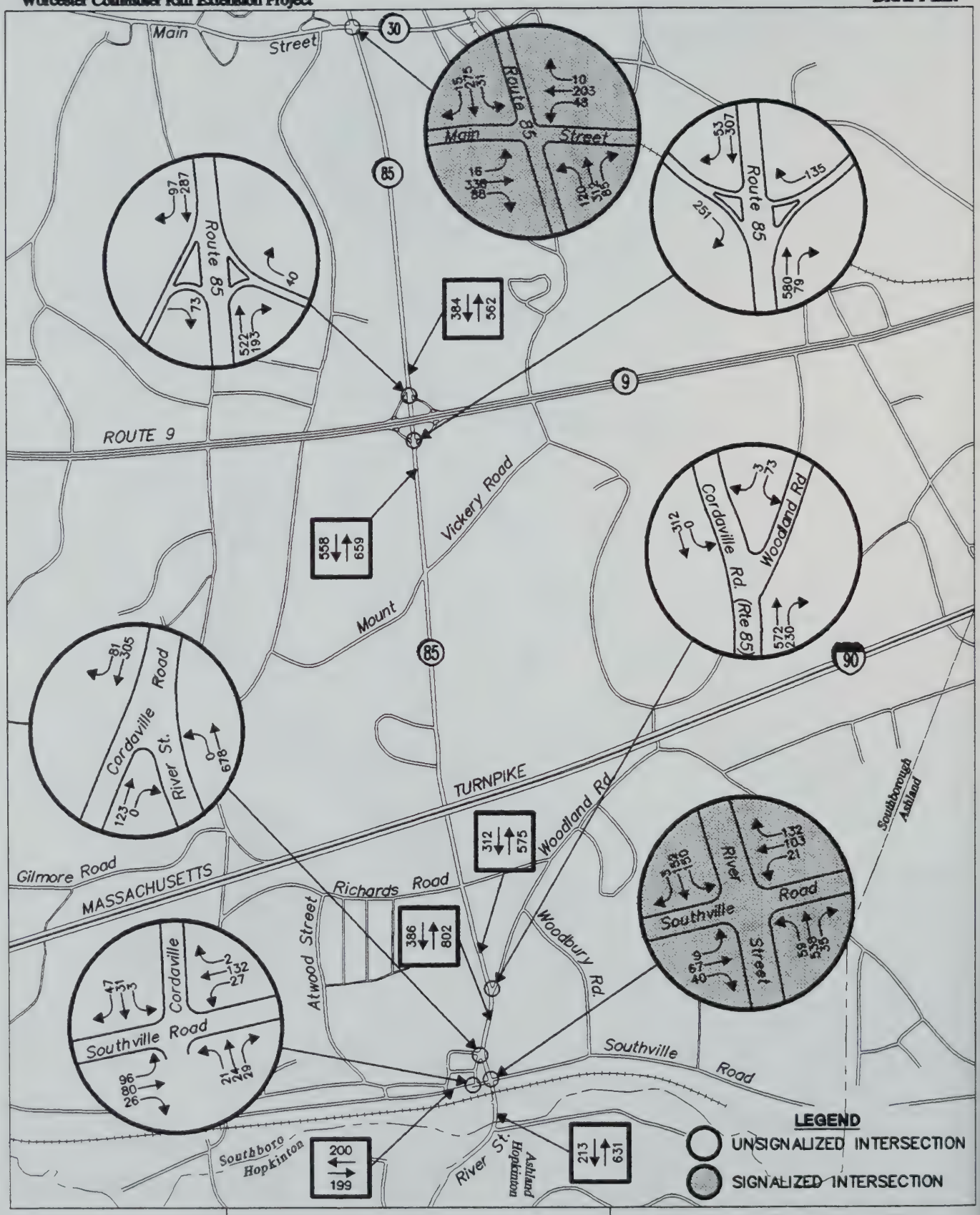
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1996 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-7

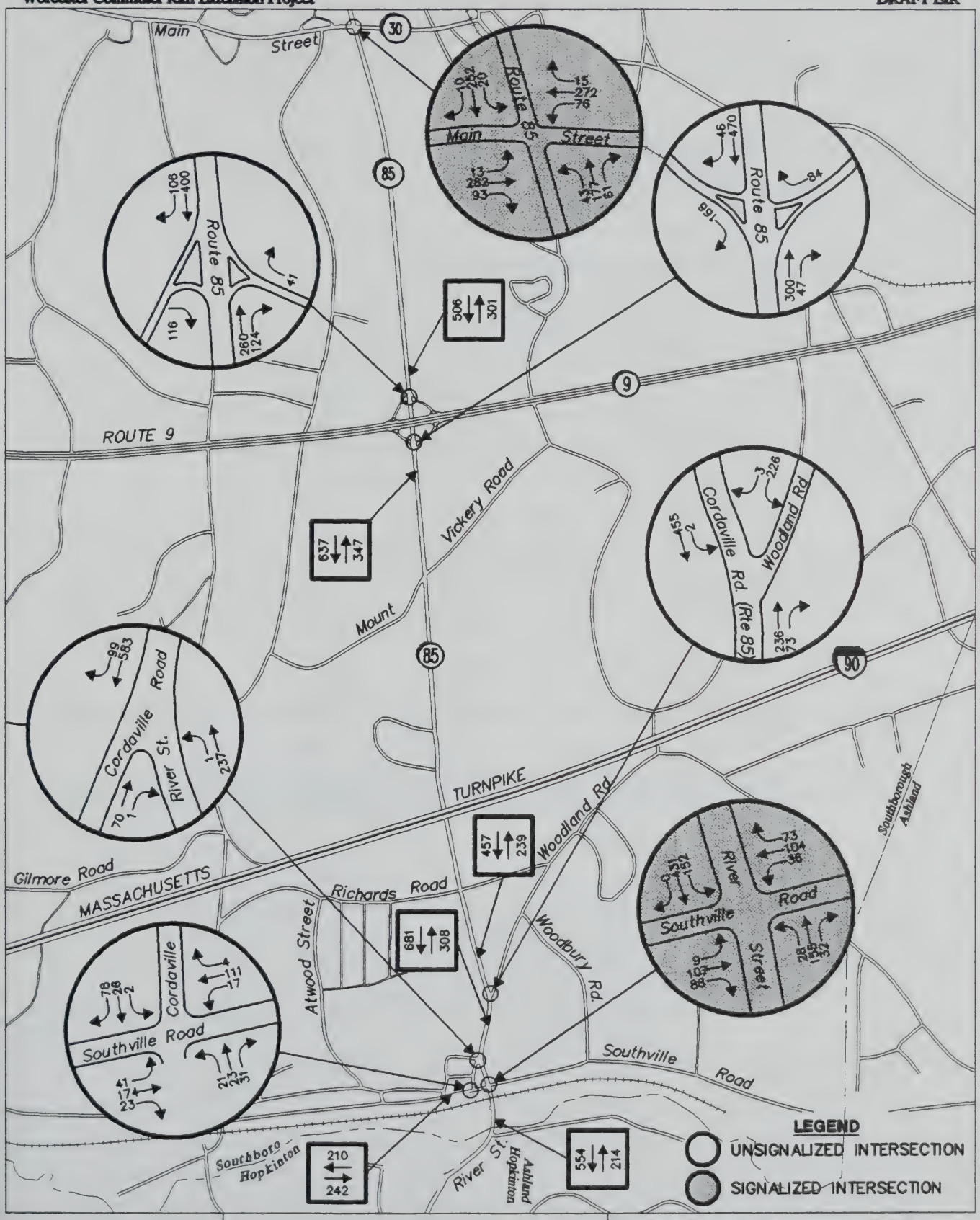


Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
1996 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-8



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-9

These ridership levels are expected to occur shortly after completion of the Southborough Station, therefore, these projections were used in the analysis of the 1996 "Build" conditions.

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, of even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.7-5 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.7-5 MBTA Ridership Distribution - Southborough Station

Inbound Train	Patrons
502A	101
504A	167
506A	168
510	80
TOTAL	**516**
Outbound Train	**Patrons**
515A	72
519	120
521	119
521A	179
523	26
TOTAL	**516**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:30 - 8:30 A.M. and 4:45 - 5:45 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Southborough Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

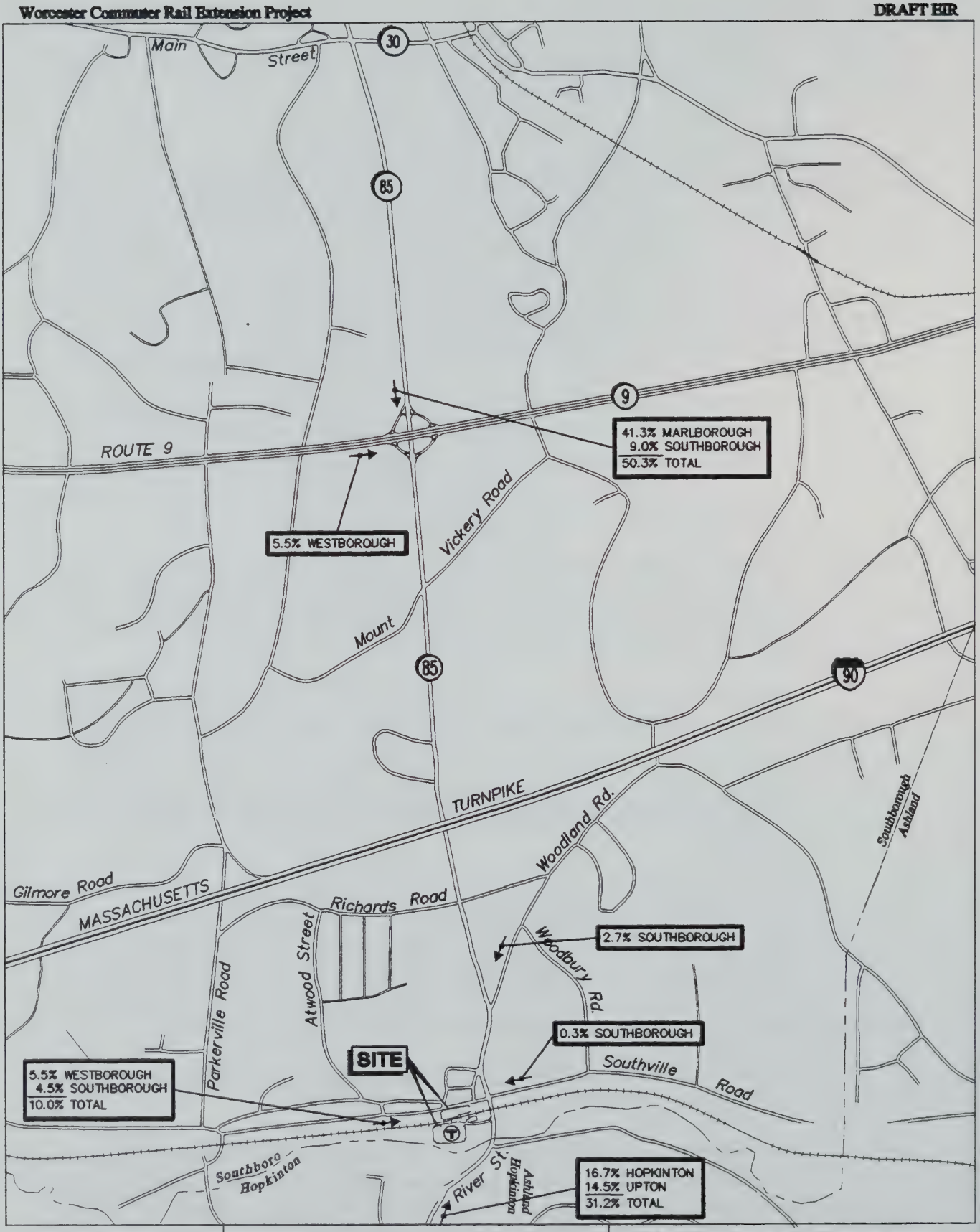
In Southborough the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:45 to 5:45 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 7:00 to 8:00 A.M. and from 5:30 to 6:30 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Southborough would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station.

Patrons from Hopkinton and Upton would access the station from Cedar Street (Route 85). Patrons from Westborough would access the station from either Route 9 to Route 85, or by Flanders Road to Southville Road. Commuters from Northborough would access the station from Route 9 to Route 85. Patrons from Grafton would access the station by Flanders Road to Southville Road. Commuters from Marlborough would access the station from Route 85.

Figure 1.7-10 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

Upon completion of the commuter rail service, commuters will shift from automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along Route 9 and 30. Traffic volumes are expected to increase on Route 85 and Southville Road.



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
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Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-10

Year 1996 "Build" Traffic Volumes

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically generated by the proposed Southborough rail station.

A portion of the traffic volumes accessing the proposed station would be diverted from traffic travelling on Route 85, not generated as completely new trips. One of the primary access routes for commuters from Hopkinton and Upton travelling to Boston is from Route 85 to Route 9. This traffic pattern currently carries these vehicles past the proposed station location. This traffic is referred to as "by-pass" traffic. Typically, 100% of this by-pass traffic would be subtracted from the respective "No Build" traffic volumes to avoid double counting these vehicles in the "Build" analysis. Since other travel routes exist, a conservative 50% adjustment was applied. Fifty percent of the traffic generated hourly by the commuter rail station from the towns of Hopkinton and Upton was subtracted from the 1996 "No Build" traffic volumes along Route 85 northbound to Route 9 eastbound in the A.M. peak hour. This same principle applies to these vehicles for the evening return trip. To adjust for the by-pass traffic for the P.M. peak hour, 50% of the traffic generated hourly by the commuter rail station from Hopkinton and Upton was subtracted from Route 9 westbound to Route 85 southbound.

Figures 1.7-11 and 1.7-12 show the A.M. and P.M. peak roadway hour traffic volumes, respectively. Figures 1.7-13 and 1.7-14 show the A.M. and P.M. peak generator hour volumes.

Year 1996 Peak Hour Level of Service

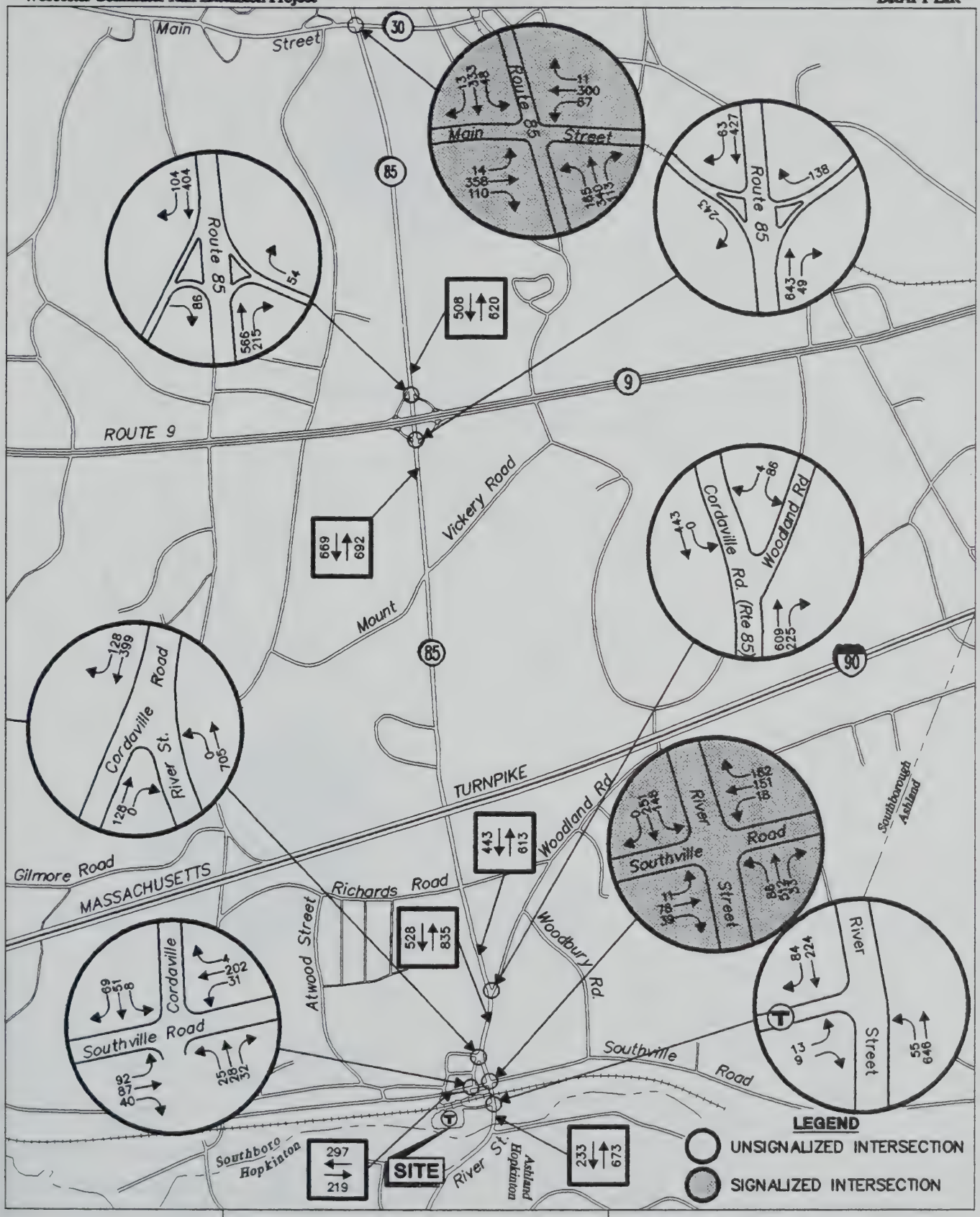
The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 1996 "No Build" condition were not changed from the existing conditions. For the 1996 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.7-6 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 1996 "No Build" and "Build" conditions.

As shown in the table, the Southville Road/River Street intersection operates at an overall unacceptable level of service during both the A.M. and P.M. peak hours for the "No Build" condition. The Southbound approach of River Street at Southville Road operates at an unacceptable LOS "F" during both the A.M. and P.M. peak hours. The northbound approach of River Street at Southville Road also operates at LOS "F" for the A.M. peak hour. These unacceptable LOS ratings are largely due to the timings set in the controller. The analysis for the "Build" condition was performed utilizing optimal timings. This resulted in acceptable LOS ratings for the overall intersection and all individual approaches.

The Cordaville Road/Main Street intersection operates at acceptable overall LOS ratings in both the A.M. and P.M. peak hours. The northbound approach operates at LOS "F" during the A.M. peak hour. Under the "Build" condition the overall LOS drops to LOS "E" in the A.M. peak hour. The westbound approach experiences a reduction in level of service rating to "E", while the northbound approach continues to operate at LOS "F". During the P.M. peak hour both the overall intersection and the individual movements continue to operate at acceptable level of service ratings. However, both the northbound and southbound approaches experience a reduction in level of service rating from LOS "B" to LOS "C".

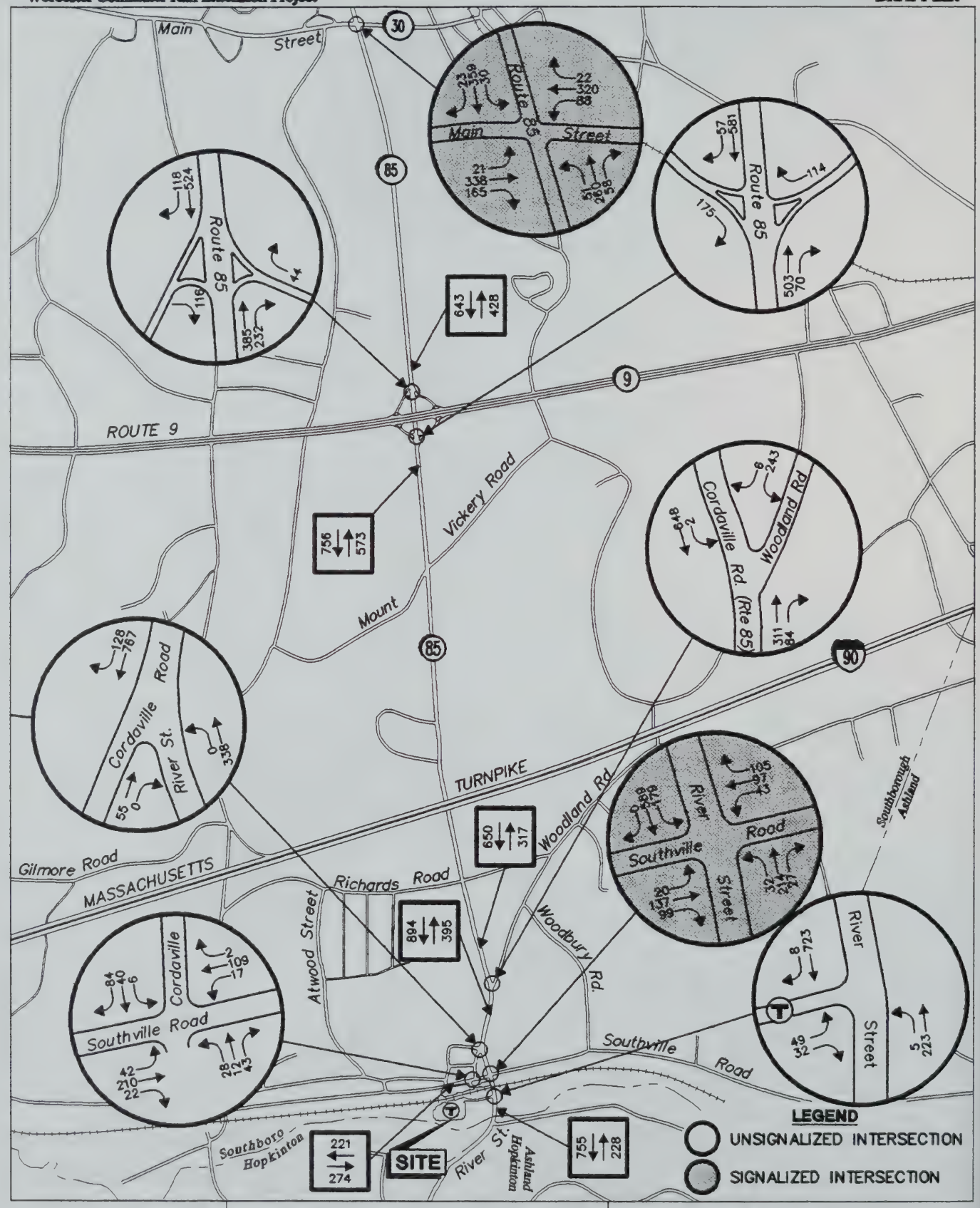


Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-11



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

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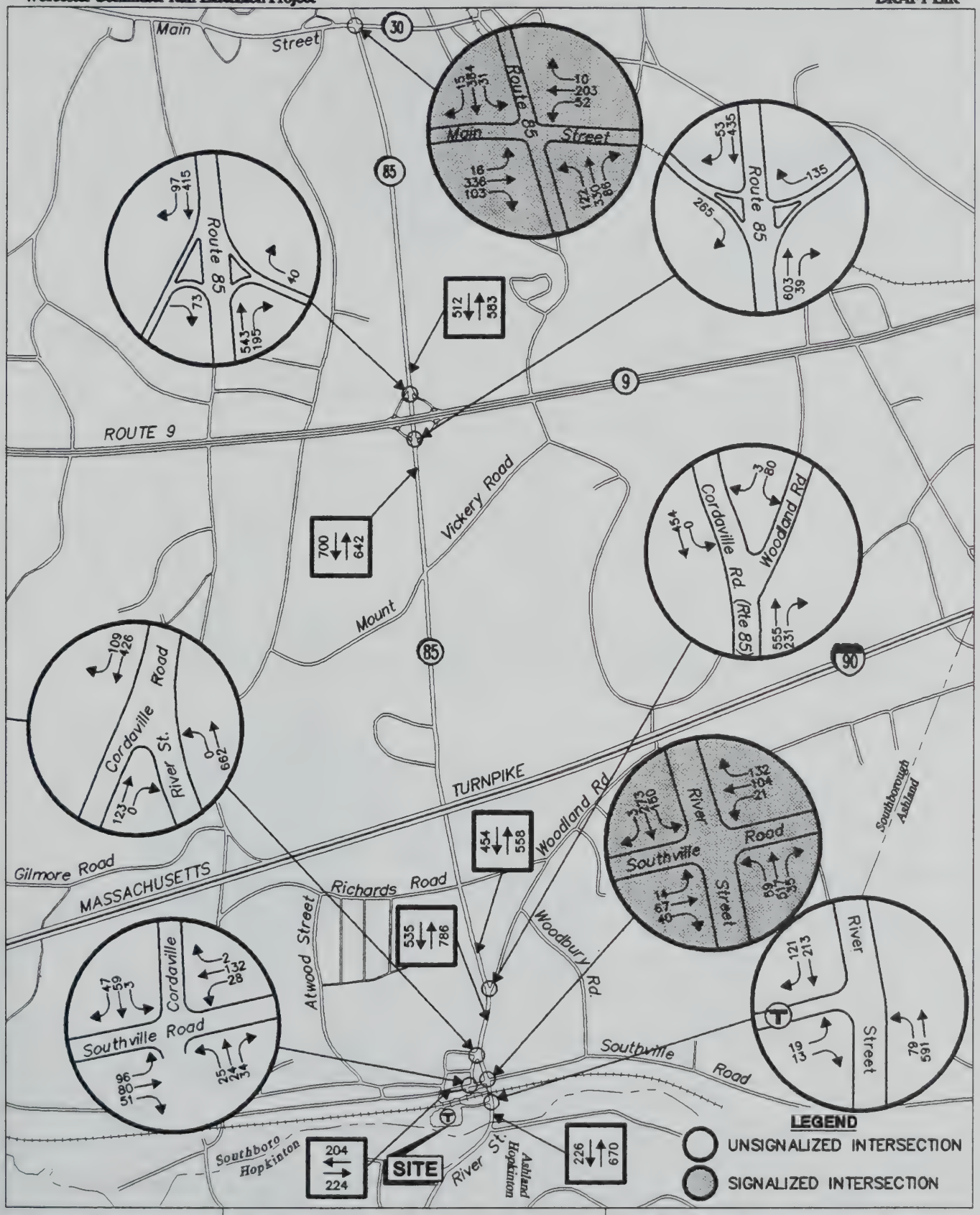
P.M. Peak Hour
4:45 - 5:45 P.M.
1996 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-12



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

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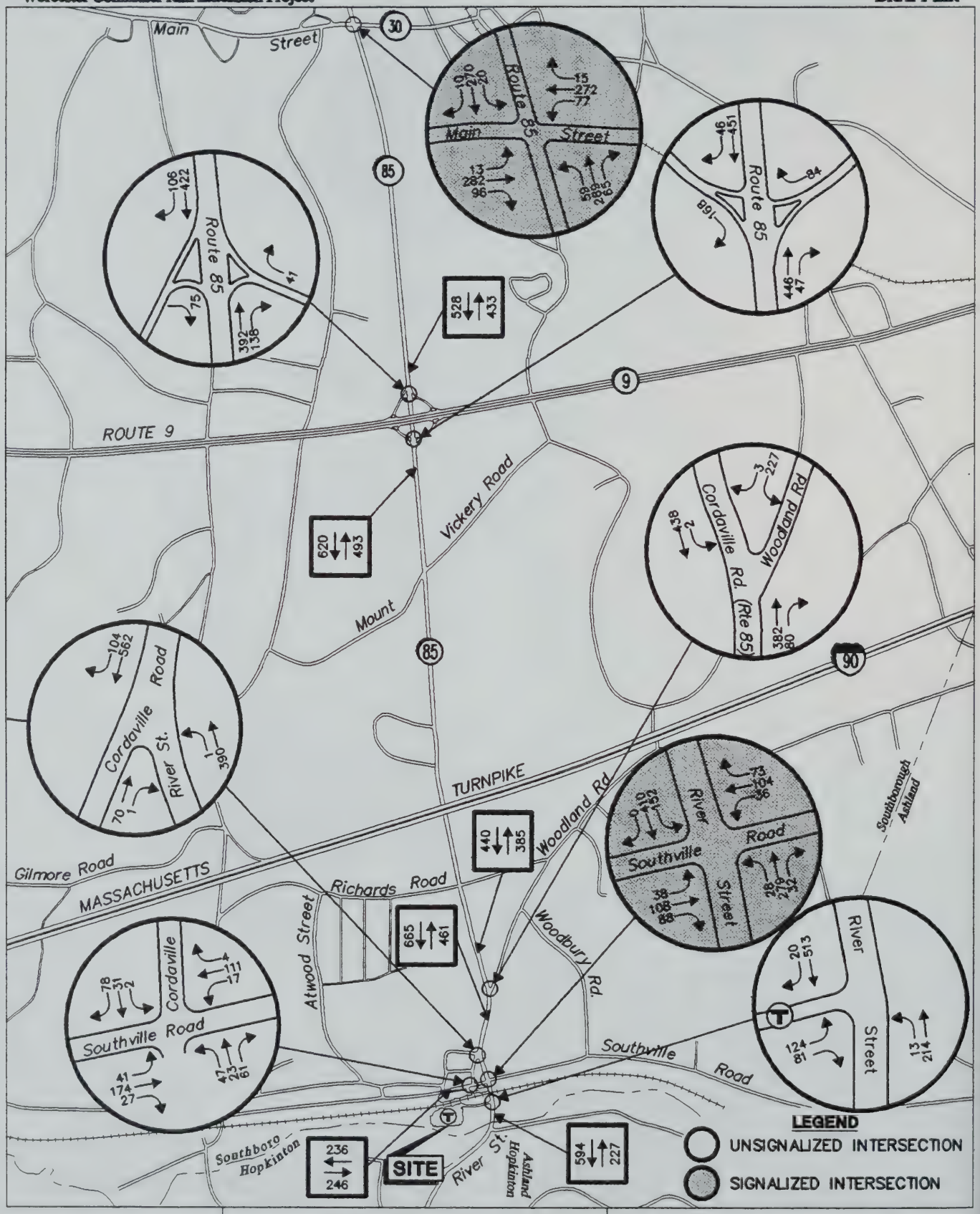
A.M. Peak Generator Hour
7:00 - 8:00 A.M.
1996 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-14

Table 1.7-6 1996 Peak Hour Signalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	F(66.0)	C(23.6)	C(15.1)
Eastbound	B(9.1)	B(10.3)	C(17.3)	C(22.3)
Westbound	B(11.9)	B(10.6)	D(38.5)	D(26.5)
Northbound	F(92.2)	C(22.0)	B(11.6)	B(5.4)
Southbound	F*	F*	D(29.7)	B(12.6)
Cordaville and Main	D(35.3)	C(19.1)	E(50.6)	C(15.3)
Eastbound	B(14.2)	C(16.2)	C(22.9)	B(12.0)
Westbound	C(16.4)	D(35.4)	E(57.4)	C(15.4)
Northbound	F(78.4)	B(11.7)	F(95.3)	C(19.3)
Southbound	B(14.0)	B(11.8)	C(15.8)	C(16.1)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.7-7.

All of the unsignalized intersections are operating at acceptable levels of service under the "No Build" and "Build" conditions for the A.M. and P.M. peak hours, with one exception. The left and right turns from Cordaville Road to River Street are operating at LOS "F" during the A.M. "Build" condition. The left and right turns from Woodland Avenue to Cordaville Road operate at LOS "E" and LOS "F" for the A.M. and P.M. "No Build" conditions, respectively. These levels of service remain in effect for the "Build" condition also.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.7-8 lists the results of this analysis for the A.M. and P.M. peak hours. Although most of the segments are classified as LOS "E" for both the "Build" and "No Build" conditions, it should be noted that all segments operate within the range of acceptable reserve capacity.

River Street south of the proposed site experiences a decline in level of service rating from LOS "D" to "E" in the A.M. peak hour. Southville Road west of the proposed site experiences a decline in level of service rating from LOS "C" to "D" in the A.M. peak hour.

Table 1.7-7 1996 Peak Hour Unsignalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southern Lot				
LT from NB River	-	-	A(765)	A(494)
LT and RT from Southern Lot	-	-		
	-	-	C(227)	D(149)
Southville and Cordaville				
LT from EB Southville	A(842)	A(993)	A(842)	A(993)
LT from WB Southville	A(1008)	A(896)	A(987)	A(894)
All from Northern Lot	A(434)	A(492)	A(404)	A(458)
All from Cordaville	A(514)	A(596)	A(454)	A(588)
Cordaville and River				
LT from NB River	A(720)	A(403)	A(638)	A(406)
LT and RT from Cordaville	E(11)	E(78)	F(-9)	E(65)
Cordaville and Woodland				
LT from SB Cordaville	A(432)	A(795)	A(439)	A(742)
LT and RT from Woodland	E(58)	F(-66)	E(31)	F(-83)
NB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	B(349)	A(505)	B(348)	A(461)
SB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	A(479)	B(344)	B(397)	B(347)
NB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(444)	A(607)	A(435)	A(564)
SB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(625)	A(423)	A(553)	A(433)

LOS (Reserve Capacity - Vehicles)

Table 1.7-8 1996 Peak Hour Road Segment Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River South of Site	D(1178)	E(1035)	E(1139)	E(1012)
Southville West of Site	C(1676)	C(1821)	D(1667)	C(1822)
Cordaville North of River	E(791)	E(793)	E(765)	E(791)
Cordaville North of Woodland	E(1157)	E(1137)	E(1154)	E(1146)
Cordaville South of Route 9	E(919)	E(912)	E(885)	E(900)
Cordaville North of Route 9	E(1116)	E(1149)	E(1076)	E(1132)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

Year 1996 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generator hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.7-9 for the 1996 "No Build" and "Build" conditions.

Under the "No Build" condition the River Street/Southville Road intersection was found to operate at an overall level of service rating of "F" in the A.M. peak generator hour and "D" in the P.M. peak generator hour. Both the northbound and southbound approaches operate at LOS "F" in the A.M. hour, while the southbound approach operates at LOS "E" in the P.M. hour. All other movements operate at acceptable level of service ratings. Under the "Build" condition, using optimized timings, the intersection was found to operate at acceptable level of service ratings during both the A.M. and P.M. peak generator hours. Only the southbound approach operates at a level of service (LOS "E") during the A.M. peak generator hour.

Under the "No Build" condition the Cordaville Road/Main Street intersection was found to operate at overall acceptable level of service ratings for both the A.M. and P.M. peak generator hours. Only the northbound approach operates at a level of service (LOS "E") during the A.M. peak generator hour. Under the "Build" condition the A.M. peak generator hour overall level of service declines to LOS "E". Both the westbound and northbound approaches operate at LOS "F". During the P.M. peak generator hour both the intersection and all individual movements continue to operate at acceptable level of service ratings. However, the level of service rating for the northbound movement declines from LOS "B" to LOS "C".

Table 1.7-9 1996 Peak Generator Hour Signalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	D(28.7)	D(26.8)	B(12.3)
Eastbound	B(9.1)	B(9.6)	C(22.5)	C(20.8)
Westbound	B(10.6)	B(10.2)	D(36.6)	C(21.2)
Northbound	F(68.7)	B(12.4)	B(7.6)	B(5.7)
Southbound	F*	E(47.2)	E(43.4)	B(9.9)
Cordaville and Main	D(28.8)	B(13.2)	E(58.9)	B(13.7)
Eastbound	B(14.1)	B(12.9)	D(27.2)	B(11.9)
Westbound	C(16.7)	C(17.5)	F(128.1)	C(15.0)
Northbound	E(59.4)	B(10.7)	F(78.3)	C(15.6)
Southbound	B(12.4)	B(10.5)	B(13.6)	B(12.0)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.7-10.

Under the "No Build" condition all intersection movements operate at acceptable level of service ratings. The left and right turns from Cordaville Road to River Street operate at LOS "E" in the A.M. peak generator hour. The left and right turns from Woodland Avenue to Cordaville Road also operate at LOS "E" during both the A.M. and P.M. peak generator hours.

Under the "Build" condition all intersection movements operate at acceptable level of service ratings with one exception. The left and right turns from Woodland Avenue to Cordaville Road operate at LOS "F" during the P.M. peak generator hour.

Table 1.7-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southern Lot				
LT from NB River	-	-	A(716)	A(621)
LT and RT from Southern Lot	-	-	C(219)	D(117)
	-	-		
Southville and Cordaville				
LT from EB Southville	A(914)	A(990)	A(914)	A(990)
LT from WB Southville	A(1014)	A(929)	A(986)	A(925)
All from Northern Lot	A(513)	A(503)	A(472)	A(433)
All from Cordaville	A(604)	A(669)	A(510)	A(647)
Cordaville and River				
LT from NB River	A(752)	A(529)	A(632)	A(540)
LT and RT from Cordaville	E(35)	D(140)	E(3)	E(95)
Cordaville and Woodland				
LT from SB Cordaville	A(457)	A(818)	A(466)	A(687)
LT and RT from Woodland	E(92)	E(42)	E(50)	F(-14)
NB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	B(383)	A(667)	B(381)	A(546)
SB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	A(482)	A(443)	B(360)	A(455)
NB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(484)	A(714)	A(470)	A(597)
SB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(669)	A(527)	A(563)	A(552)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.7-11 lists the results of this analysis for the A.M. and P.M. peak generator hours.

As shown in the table, several of the roadway segments operate at LOS "E" for the "No Build" and "Build" conditions. However, all the analyzed roadway segments operate within the range of acceptable reserve capacity.

Table 1.7-11 1996 Peak Generator Hour Road Segment Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River South of Site	D(1149)	D(1316)	E(1094)	D(1259)
Southville West of Site	C(1909)	C(1884)	C(1849)	C(1895)
Cordaville North of River	E(889)	E(1099)	E(844)	E(1087)
Cordaville North of Woodland	D(1235)	D(1441)	E(1232)	D(1485)
Cordaville South of Route 9	E(1017)	E(1152)	E(913)	E(1145)
Cordaville North of Route 9	E(1203)	D(1367)	E(1139)	D(1310)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.7-12 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in the table, only the intersection of the site driveway from the southern lot with River Street is expected to exceed the ten percent criteria. The roadway segment of Cordaville Road north of Woodland Road is expected to exceed the ten percent criteria threshold.

Table 1.7-12 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
River and Southern Lot	15.6%	9.0%
River and Southville	6.7%	4.4%
Southville and Northern Lot	6.6%	4.2%
Cordaville and River	8.8%	5.5%
Cordaville and Woodland	8.7%	5.5%
Cordaville and Route 9 East Ramps	7.2%	4.5%
Cordaville and Route 9 West Ramps	7.2%	4.7%
Cordaville and Main	5.4%	3.5%
Roadway Segment		
Southville West of North Lot	**4.1%**	**2.4%**
River South of Southern Lot	**7.1%**	**3.8%**
Cordaville North of River	**8.7%**	**5.5%**
Cordaville North of Woodland	**10.7%**	**7.0%**
Cordaville South of Route 9	**8.3%**	**5.1%**
Cordaville North of Route 9	**9.0%**	**5.7%**

Site generated traffic as a percentage of total traffic

Year 1996 Southborough Station Only

In order to address an upper limit, worse case situation with regard to traffic impacts on Southborough streets, an analysis was performed which considered that the Southborough commuter station was the only station built by 1996 (in addition to a Worcester Station).

The 1996 "No Build" traffic volumes, for both the peak hours and peak generator hours, were previously presented and serve as the base for the "Southborough Station Only" as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Southborough Station Only)

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership for the Southborough Station, employing unconstrained parking supply. In 1996 the Southborough Station is

projected to attract a total of 636 daily round trip commuters. These patrons are expected to reside in the Towns of Southborough, Hopkinton, Marlborough, Milford, Upton, Westborough, Northborough and Grafton. The number of patrons who originate from each community are shown in Table 1.7-13. The ridership has been revised to reflect the peak period usage which is 94% of the total daily demand.

Table 1.7-13 Projected Patrons of Southborough Station Only Year 1996

Town	Riders*
Southborough	110
Hopkinton	109
Marlborough	180
Milford	28
Upton	24
Westborough	78
Northborough	51
Grafton	17
TOTAL	**597**

* *Adjusted for peak period demand*

Year 1996 Trip Distribution and Assignment (Southborough Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Appendix 1.1.

Table 1.7-14 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.7-14 MBTA Ridership Distribution (Southborough Station Only)	
Inbound Train	**Patrons**
502A	117
504A	193
506A	194
510	93
TOTAL	**597**
Outbound Train	**Patrons**
515A	84
519	139
521	138
521A	206
523	30
TOTAL	**597**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Southborough Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 1 to 2 minutes on average.

In Southborough the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 4:45 to 5:45 P.M. With the proposed commuter rail schedule the peak hours for the commuter rail station will be from 7:00 to 8:00 A.M. and from 5:30 to 6:30 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside

in Southborough would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station.

Patrons from Hopkinton, Milford, and Upton would access the station from Cedar Street (Route 85). Patrons from Westborough would access the station from either Route 9 to Route 85, or by Flanders Road to Southville Road/Commuters from Marlborough would access the station from Cordaville Road (Route 85).

Figure 1.7-15 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

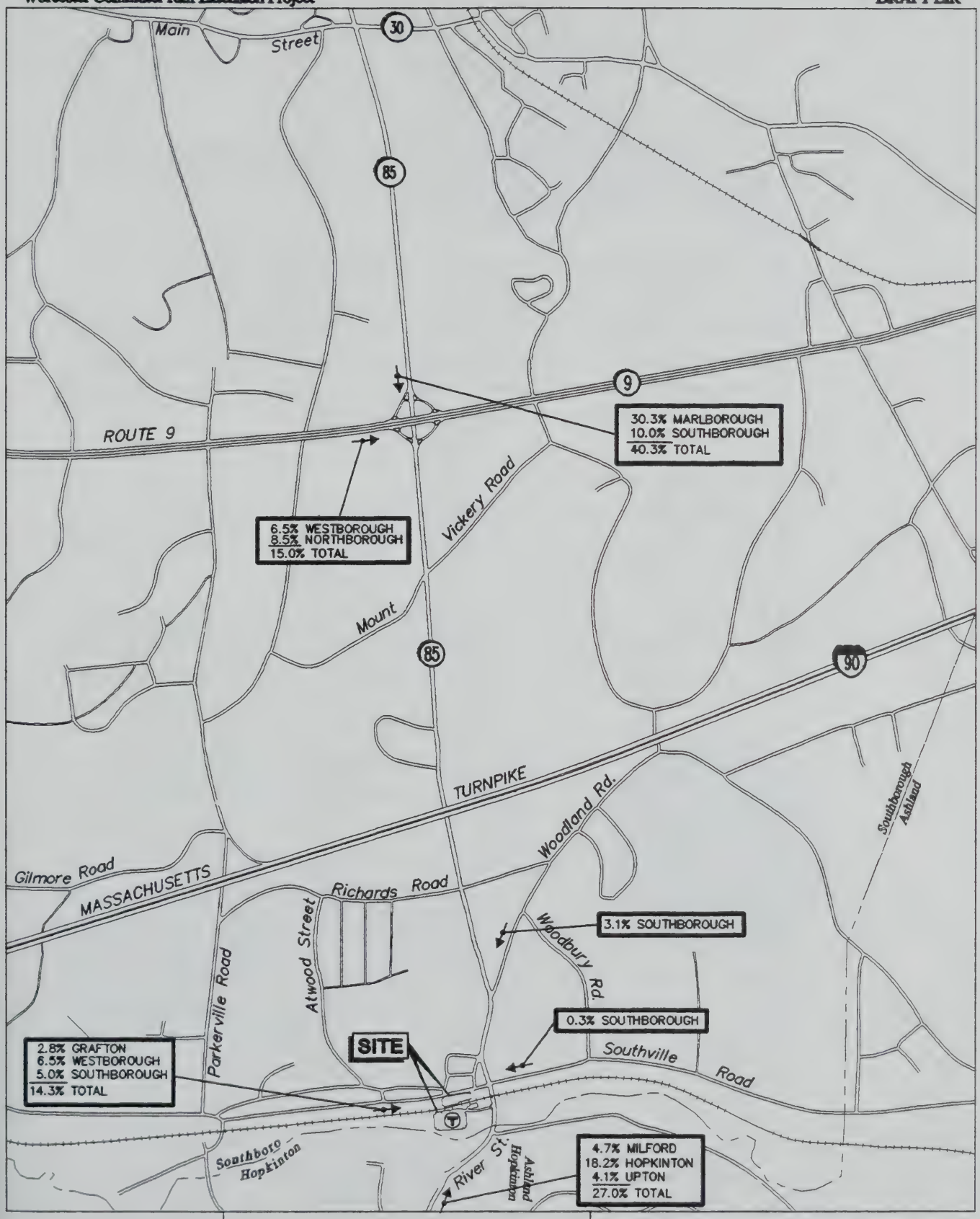
Upon completion of the commuter rail service, commuters will shift from automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the Study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along Route 9 and 30. Traffic volumes are expected to increase on Route 85 and Southville Road.

Year 1996 "Build" Traffic Volumes (Southborough Station Only)

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically generated by the proposed Southborough rail station.

A portion of the traffic volumes accessing the proposed station would be diverted from traffic travelling on Route 85, not generated as completely new trips. One of the primary access routes for commuters from Hopkinton and Upton travelling to Boston is from Route 85 to Route 9. This traffic pattern currently carries these vehicles past the proposed station location. This traffic is referred to as "by-pass" traffic. Typically, 100% of this by-pass traffic would be subtracted from the respective "No Build" traffic volumes to avoid double counting these vehicles in the "Build" analysis. Since other travel routes exist, a conservative 50% adjustment was applied. Fifty percent of the traffic generated hourly by the commuter rail station from the towns of Hopkinton and Upton was subtracted from the 1996 "No Build" traffic volumes along Route 85 northbound to Route 9 eastbound in the A.M. peak hour. This same principle applies to these vehicles for the evening return trip. To adjust for the by-pass traffic for the P.M. peak hour, 50% of the traffic generated hourly by the commuter rail station from Hopkinton and Upton was subtracted from Route 9 westbound to Route 85 southbound.



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

Distribution of Commuter Rail Station Traffic
1996 BUILD Southborough Only
SOUTHBOROUGH STATION

FIGURE 1.7-15

Figures 1.7-16 and 1.7-17 show the A.M. and P.M. peak roadway hour traffic volumes, respectively. Figures 1.7-18 and 1.7-19 show the A.M. and P.M. peak generator hour volumes, respectively.

Year 1996 Peak Hour Level of Service (Southborough Station Only)

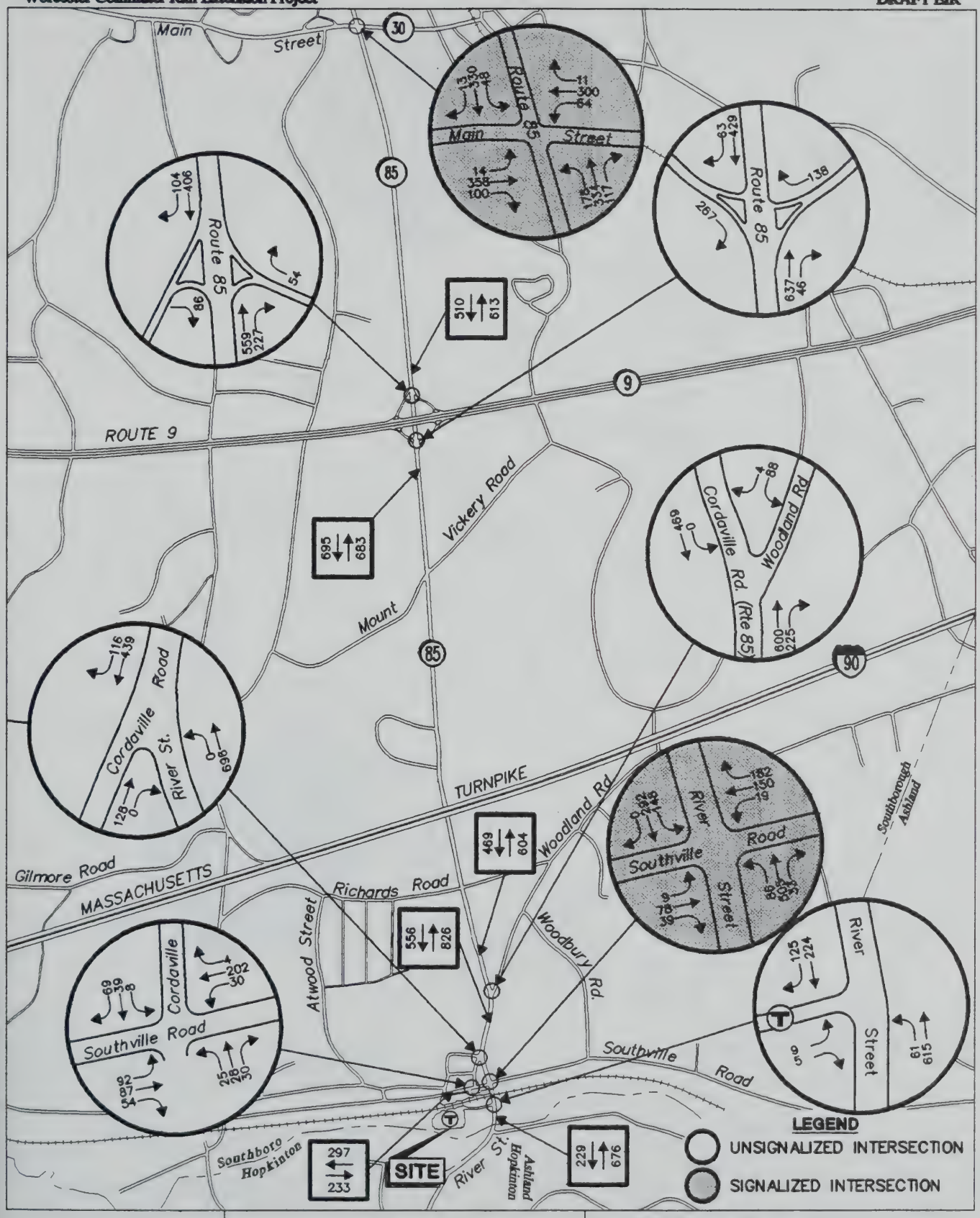
The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics, etc. remain unchanged.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.7-15 lists the results of the signalized intersection analysis for the A.M. and P.M. peak hours.

As previously mentioned, under the "No Build" condition the intersection of River Street/Southville Road operates at an overall LOS "F" during both the A.M. and P.M. peak hours. The northbound approach operates at LOS "F" during the A.M. peak hour while the southbound approach operates at LOS "F" during both the A.M. and P.M. peak hours. Under the "Build" condition and utilizing optimized timing the intersection will operate at overall acceptable levels of service in both the A.M. and P.M. peak hours. Only the westbound movement is expected to experience some excessive delay in the A.M. peak hour.

The Cordaville Road/Main Street intersection operates at acceptable levels of service under the "No Build" condition during both the A.M. and P.M. peak periods. Only the northbound approach during the A.M. peak hour operates at an unacceptable level of service (LOS "F"). Under the "Build" condition and utilizing optimized timing the intersection will operate at LOS "E" in the A.M. and LOS "C" in the P.M. peak hour. The westbound and northbound approaches are expected to experience excessive delays in the A.M. peak hour. All movements operate acceptably in the P.M. peak hour.



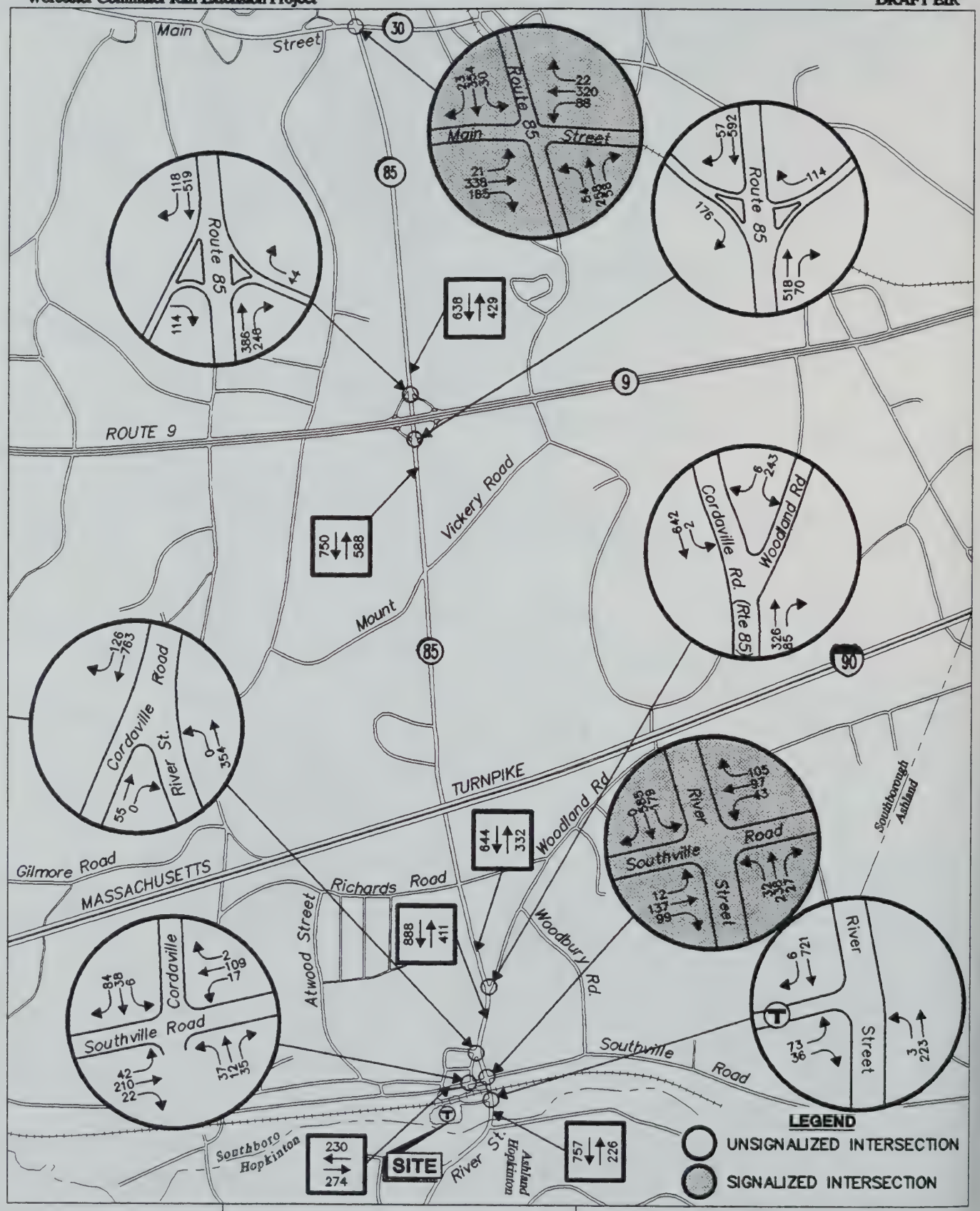
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD Southborough Only
SOUTHBOROUGH STATION

FIGURE 1.7-16

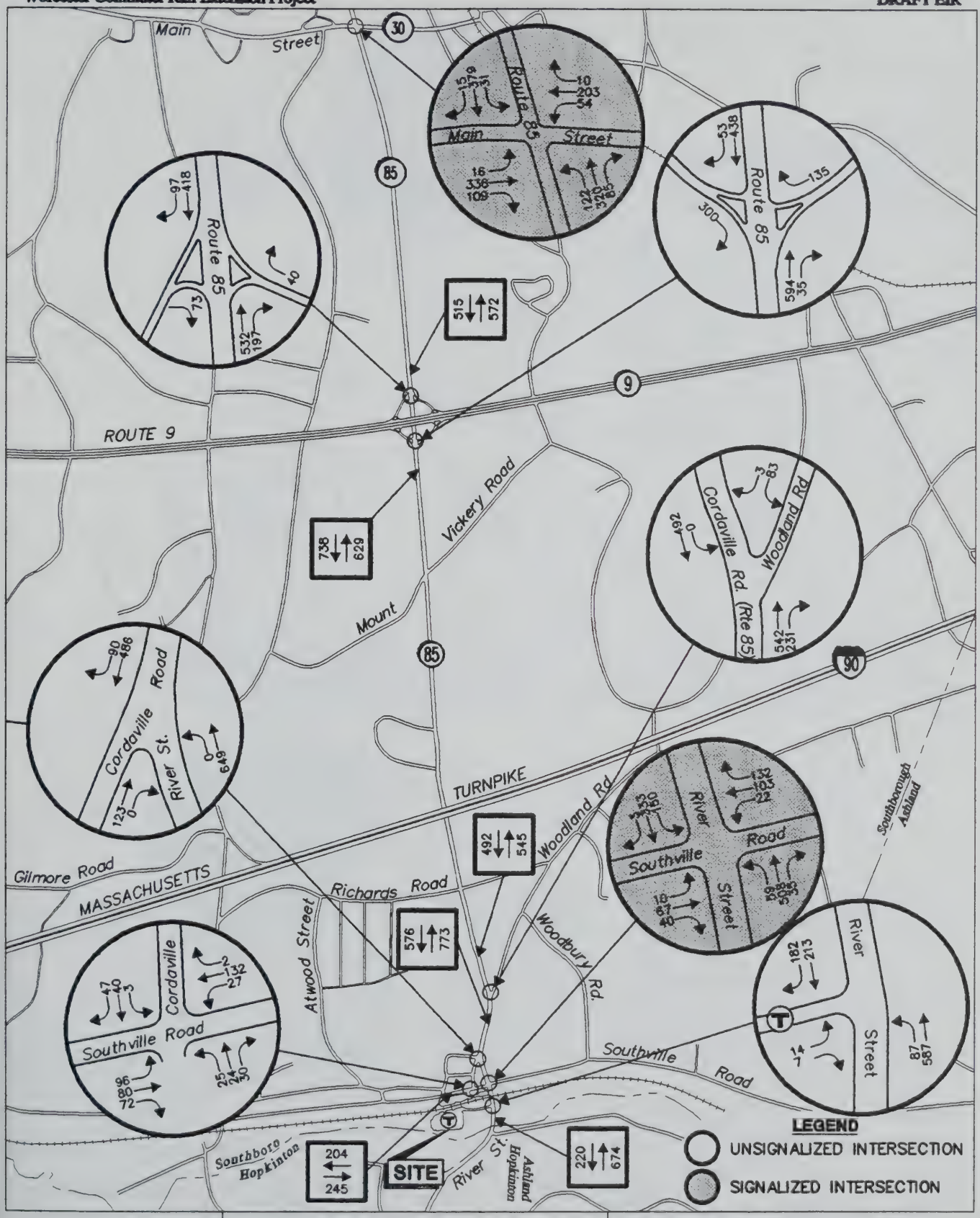


Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
1996 BUILD Southborough Only
SOUTHBOROUGH STATION

FIGURE 1.7-17

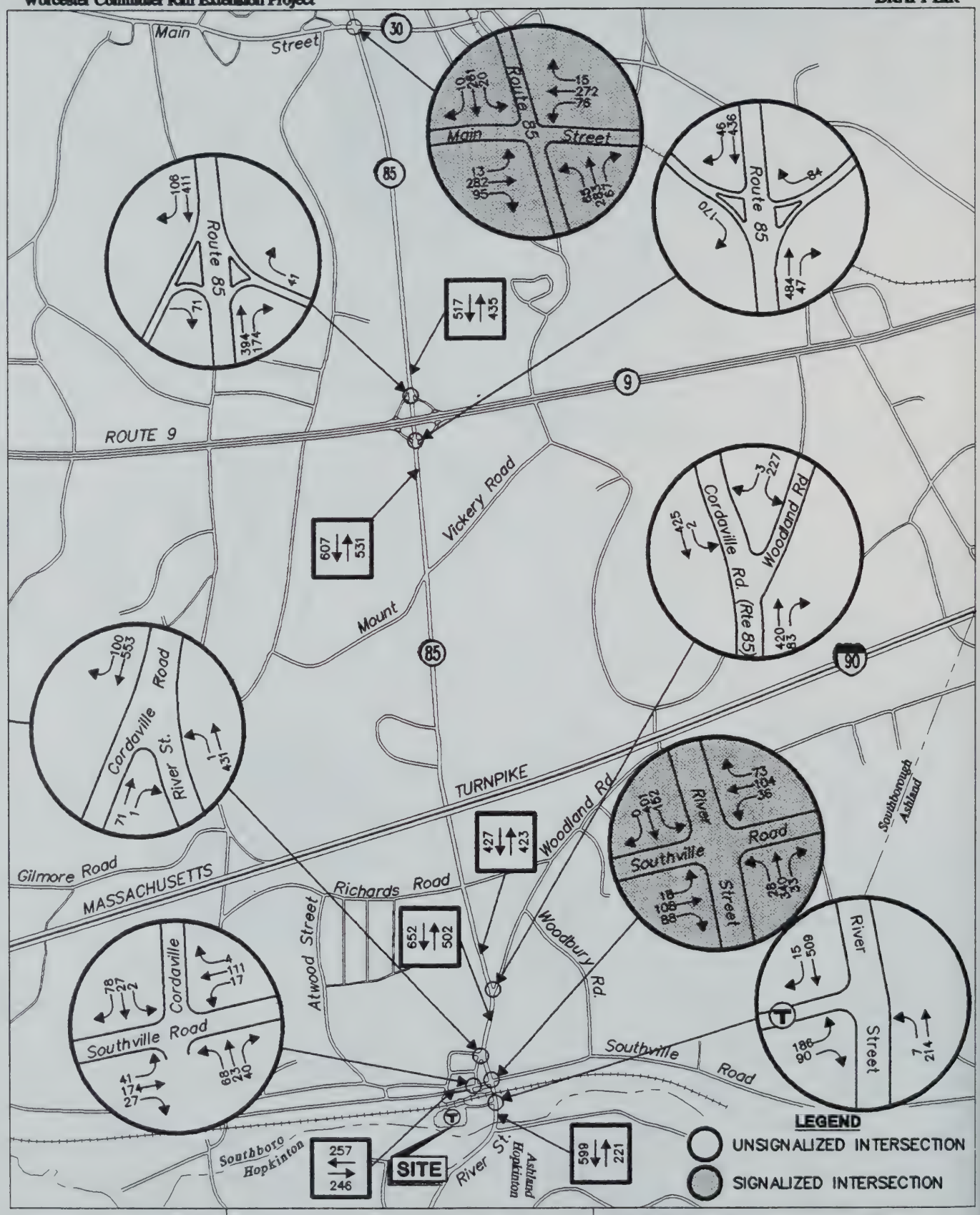


Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
0 1750

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
1996 BUILD Southborough Only
SOUTHBOROUGH STATION

FIGURE 1.7-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 BUILD Southborough Only
SOUTHBOROUGH STATION

FIGURE I.7-19

Table 1.7-15 1996 Peak Hour Signalized Intersection Level of Service (Southborough Station Only)

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	F(66.0)	D(27.2)	B(15.0)
Eastbound	B(9.1)	B(10.3)	C(20.3)	C(21.0)
Westbound	B(11.9)	B(10.6)	E(55.2)	D(26.1)
Northbound	F(92.2)	C(22.0)	B(11.4)	B(5.6)
Southbound	F*	F*	D(28.8)	B(13.3)
Cordaville and Main	D(35.3)	C(19.1)	E(53.8)	C(15.4)
Eastbound	B(14.2)	C(16.2)	C(22.0)	B(12.0)
Westbound	C(16.4)	D(35.4)	E(43.8)	C(15.4)
Northbound	F(78.4)	B(11.7)	F(113.4)	C(19.6)
Southbound	B(14.0)	B(11.8)	C(15.8)	C(15.9)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.7-16 lists the results of the analysis for the A.M. and P.M. peak hours.

As previously mentioned, under the "No Build" condition all intersection movements operate at acceptable levels of service with one exception. The left and right turns from Woodland Avenue to Cordaville Road operate at LOS "F" in the P.M. peak hour. Under the "Build" condition the left and right turning traffic from Cordaville Road to River Street deteriorates to LOS "F" in the A.M. peak hour. The left and right turns from Woodland Road to Cordaville Road continue to operate at LOS "F" in the P.M. period.

Table 1.7-16 1996 Peak Hour Unsignalized Intersection Level of Service (Southborough Station Only)

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southern Lot				
LT from NB River	-	-	A(722)	A(499)
LT and RT from Southern Lot	-	-	C(220)	D(113)
	-	-		
Southville and Cordaville				
LT from EB Southville	A(842)	A(993)	A(842)	A(993)
LT from WB Southville	A(1008)	A(896)	A(973)	A(894)
All from Northern Lot	A(434)	A(492)	A(405)	A(417)
All from Cordaville	A(514)	A(596)	A(478)	A(595)
Cordaville and River				
LT from NB River	A(720)	A(403)	A(618)	A(409)
LT and RT from Cordaville	E(11)	E(78)	F(-15)	E(63)
Cordaville and Woodland				
LT from SB Cordaville	A(432)	A(795)	A(444)	A(728)
LT and RT from Woodland	E(58)	F(-66)	E(30)	F(-86)
NB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	B(349)	A(505)	B(353)	A(451)
SB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	A(479)	B(344)	B(371)	B(339)
NB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(444)	A(607)	A(435)	A(558)
SB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(625)	A(423)	A(551)	A(438)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments were analyzed using the same methodology as in the existing conditions. The results of the analysis are presented in Table 1.7-17.

As in the previous analysis, many roadway segments operate at LOS "E" under both the "No Build" and the "Build" conditions. However, all segments continue to operate within the range of acceptable reserve capacity.

Table 1.7-17 1996 Peak Hour Road Segment Level of Service (Southborough Station Only)

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River South of Site	D(1178)	E(1035)	E(1125)	E(1012)
Southville West of Site	C(1676)	C(1821)	D(1680)	C(1827)
Cordaville North of River	E(791)	E(793)	E(757)	E(792)
Cordaville North of Woodland	E(1157)	E(1137)	E(1165)	E(1149)
Cordaville South of Route 9	E(919)	E(912)	E(881)	E(906)
Cordaville North of Route 9	E(1116)	E(1149)	E(1081)	E(1136)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

Year 1996 Peak Generator Hour Level of Service (Southborough Station Only)

Signalized Intersections

Results of the A.M. and P.M. peak generator analysis are presented in Table 1.7-18.

As in the previous analysis, under the "No Build" condition the River Street/Southville Road intersection operates at an overall LOS "F" in the A.M. peak generator hour. Both the northbound and southbound approaches also operate at LOS "F" in the A.M. peak hour. During the P.M. peak hour the overall intersection and all movements operate at acceptable levels of service. Under the "Build" condition and using optimized timing overall level of service at the intersection will be acceptable during both the A.M. and P.M. hours. The westbound and southbound approaches will operate at LOS "E" in the A.M. peak generator hour.

The Cordaville Road/Main Street intersection will operate at acceptable levels of service under the "No Build" condition during both the A.M. and P.M. peak generator hours. Only the northbound approach in the A.M. hour will experience some excessive delay. Under the "Build" condition overall A.M. peak generator hour level of service declines to LOS "E", with the westbound and northbound approaches operating at LOS "F". During the P.M. peak generator hour the overall intersection and all individual movements operate at acceptable levels of service.

Table 1.7-18 1996 Peak Generator Hour Signalized Intersection Level of Service (Southborough Station Only)

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	D(28.7)	D(33.9)	B(12.6)
Eastbound	B(9.1)	B(9.6)	C(28.9)	C(18.7)
Westbound	B(10.6)	B(10.2)	E(59.6)	C(21.0)
Northbound	F(68.7)	B(12.4)	B(7.5)	B(6.4)
Southbound	F*	E(47.2)	E(48.6)	B(11.8)
Cordaville and Main	D(28.8)	B(13.2)	E(58.4)	B(13.8)
Eastbound	B(14.1)	B(12.9)	C(22.6)	B(11.9)
Westbound	C(16.7)	C(17.5)	F(69.8)	B(14.8)
Northbound	E(59.4)	B(10.7)	F(117.0)	C(16.3)
Southbound	B(12.4)	B(10.5)	C(15.8)	B(12.1)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

The results of the unsignalized intersection analysis for the A.M. and P.M. peak generator hours is presented in Table 1.7-19.

As previously mentioned, under the "No Build" condition all intersection movements will operate at acceptable levels of service with the exception of two movements. The left and right turn movement from Cordaville Road to River Street will operate at LOS "E" in the A.M. hour. The left and right turn movement from Woodland Avenue to Cordaville Road will operate at LOS "E" in both the A.M. and P.M. peak generator hours. Under the "Build" condition the left and right turn movement from Cordaville Road to River Street will deteriorate to LOS "F" in the A.M. peak and LOS "E" in the P.M. peak. The left and right turn movement from Woodland Avenue to Cordaville Road will continue at LOS "E" in the A.M. peak and decline to LOS "F" in the P.M. peak generator hour.

Table 1.7-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Southborough Station Only)

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southern Lot				
LT from NB River	-	-	A(655)	A(634)
LT and RT from Southern Lot	-	-	D(195)	E(39)
	-	-		
Southville and Cordaville				
LT from EB Southville	A(914)	A(990)	A(914)	A(990)
LT from WB Southville	A(1014)	A(929)	A(965)	A(925)
All from Northern Lot	A(513)	A(503)	A(471)	B(376)
All from Cordaville	A(604)	A(669)	A(548)	A(663)
Cordaville and River				
LT from NB River	A(752)	A(529)	A(602)	A(548)
LT and RT from Cordaville	E(35)	D(140)	F(-5)	E(85)
Cordaville and Woodland				
LT from SB Cordaville	A(457)	A(818)	A(474)	A(655)
LT and RT from Woodland	E(92)	E(42)	E(41)	F(-24)
NB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	B(383)	A(667)	B(388)	A(517)
SB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	A(482)	A(443)	B(321)	A(465)
NB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(484)	A(714)	A(476)	A(582)
SB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(669)	A(527)	A(560)	A(564)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The results of the analysis for the A.M. and P.M. peak generator hours are presented in Table 1.7-20.

As in the previous analysis many roadway segments operate at LOS "E" in both the "No Build" and the "Build" condition. However, all the roadway segments operate within the range of acceptable reserve capacity.

Table 1.7-20 1996 Peak Generator Hour Road Segment Level of Service (Southborough Station Only)

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River South of Site	D(1149)	D(1316)	E(1096)	D(1245)
Southville West of Site	C(1909)	C(1884)	C(1783)	C(1872)
Cordaville North of River	E(889)	E(1099)	E(857)	E(1101)
Cordaville North of Woodland	D(1235)	D(1441)	E(1234)	D(1502)
Cordaville South of Route 9	E(1017)	E(1152)	E(858)	E(1161)
Cordaville North of Route 9	E(1203)	D(1367)	E(1148)	D(1334)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 1996 "Ten Percent of Traffic" Analysis (Southborough Station Only)

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.7-21 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. roadway peak hours for the intersections and road segments analyzed.

Three of the eight intersections analyzed are expected to exceed the ten percent criteria during the A.M. or P.M. peak hours. They are the following intersections:

- River Street with the Site's southern Parking Lot
- Cordaville Road with River Street
- Cordaville Road with Woodland Road

Two of the six road segments analyzed are expected to exceed the ten percent criteria during the A.M. peak hour. They are the following road segments:

- Cordaville Road North of River Street
- Cordaville Road North of Woodland

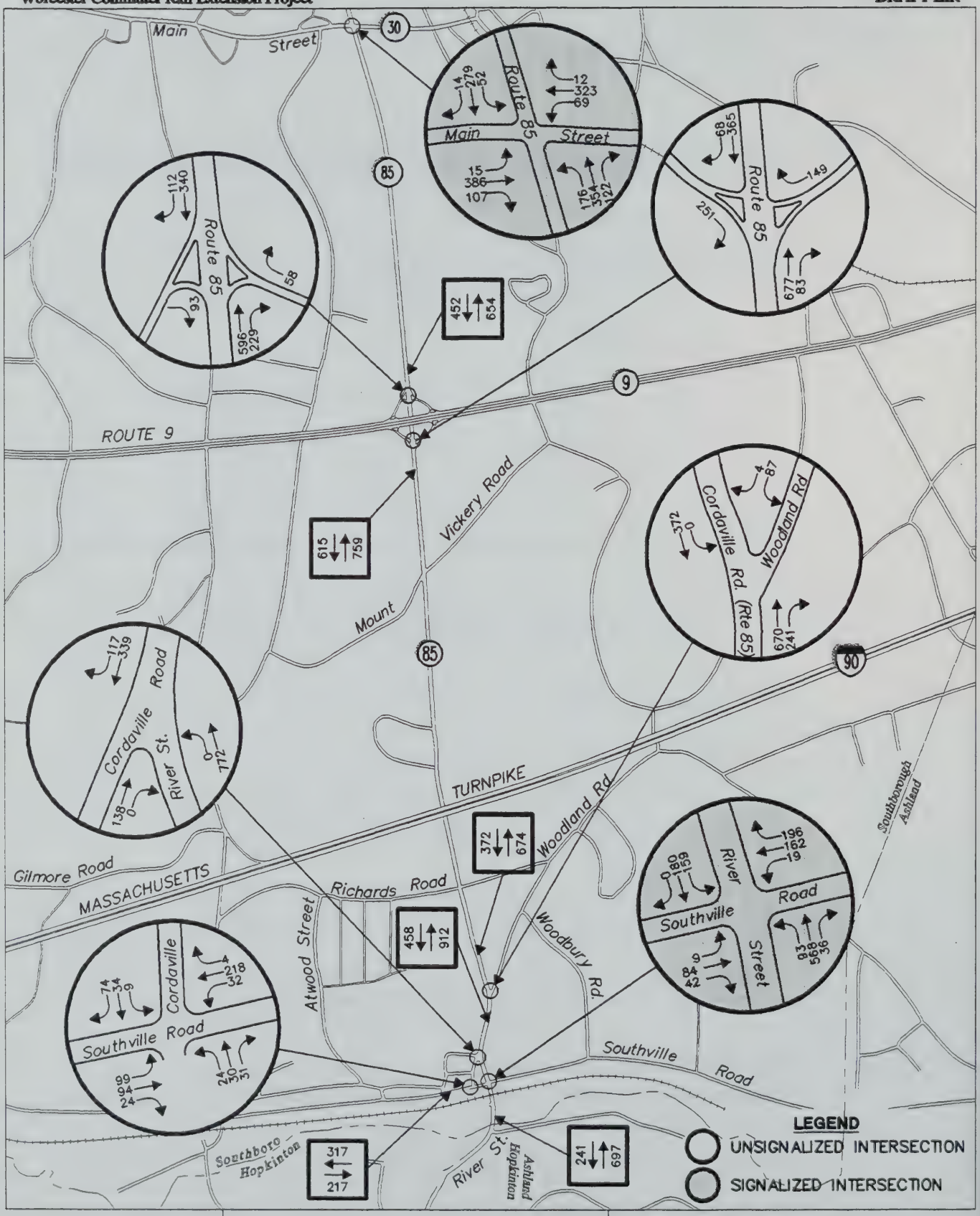
Table 1.7-21 2001 "Build" Condition - 10% Analysis (Southborough Station Only)		
Intersection	Peak Hours	
	A.M.	P.M.
River and Southern Lot	19.2%	11.1%
River and Southville	8.8%	5.3%
Southville and Northern Lot	6.4%	4.1%
Cordaville and River	10.2%	6.4%
Cordaville and Woodland	10.2%	6.4%
Cordaville and Route 9 East Ramps	8.4%	5.2%
Cordaville and Route 9 West Ramps	6.9%	5.4%
Cordaville and Main	5.1%	3.3%
Roadway Segment		
Southville West of North Lot	6.8%	4.2%
River South of Southern Lot	7.3%	4.0%
Cordaville North of River	10.2%	6.4%
Cordaville North of Woodland	12.4%	8.1%
Cordaville South of Route 9	9.7%	5.9%
Cordaville North of Route 9	8.5%	5.3%
Site generated traffic as a percentage of total traffic		

Year 2001 Conditions

Similar to the year 1996 conditions, an analysis was performed for the projected "No Build" and "Build" traffic conditions in the year 2001. Procedures and methodology for this analysis were the same as under the 1996 condition analysis. A detailed description of the analysis methodology is presented in Section 1.1 of this report.

Year 2001 "No Build" Traffic Volumes

To determine the year 2001 "No Build" traffic volumes, the traffic volumes under the 1996 "No Build" conditions were adjusted based on anticipated growth in population and employment throughout the region. A growth rate of 1.5 percent per year was applied to the 1996 "No Build" traffic volumes. At this time, no significant developments are planned proximate to the study area. Figures 1.7-20 and 1.7-21



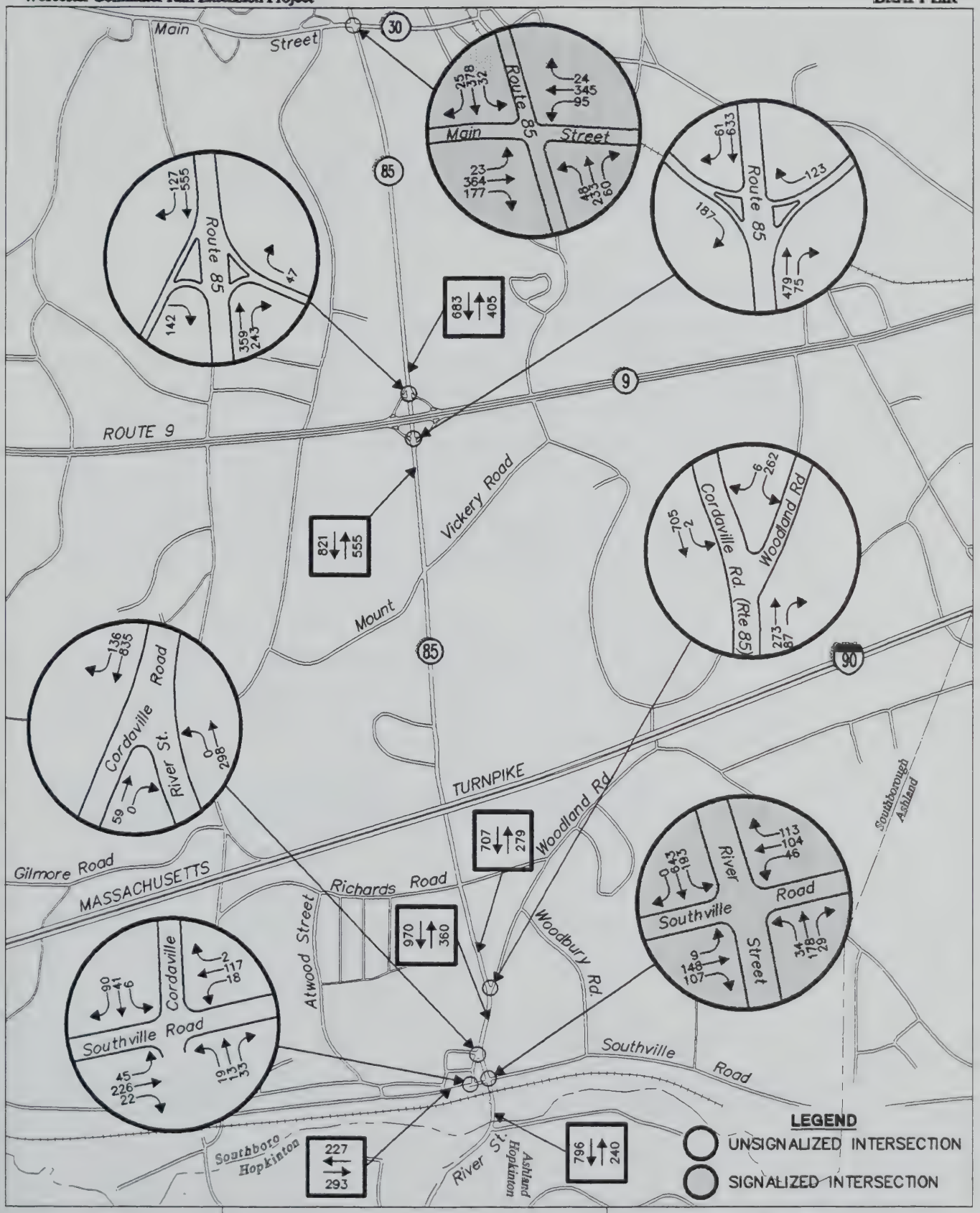
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-20



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
2001 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-21

show the projected 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak hour. Figures 1.7-22 and 1.7-23 show the projected year 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak generator hours.

Year 2001 Trip Generation/Parking

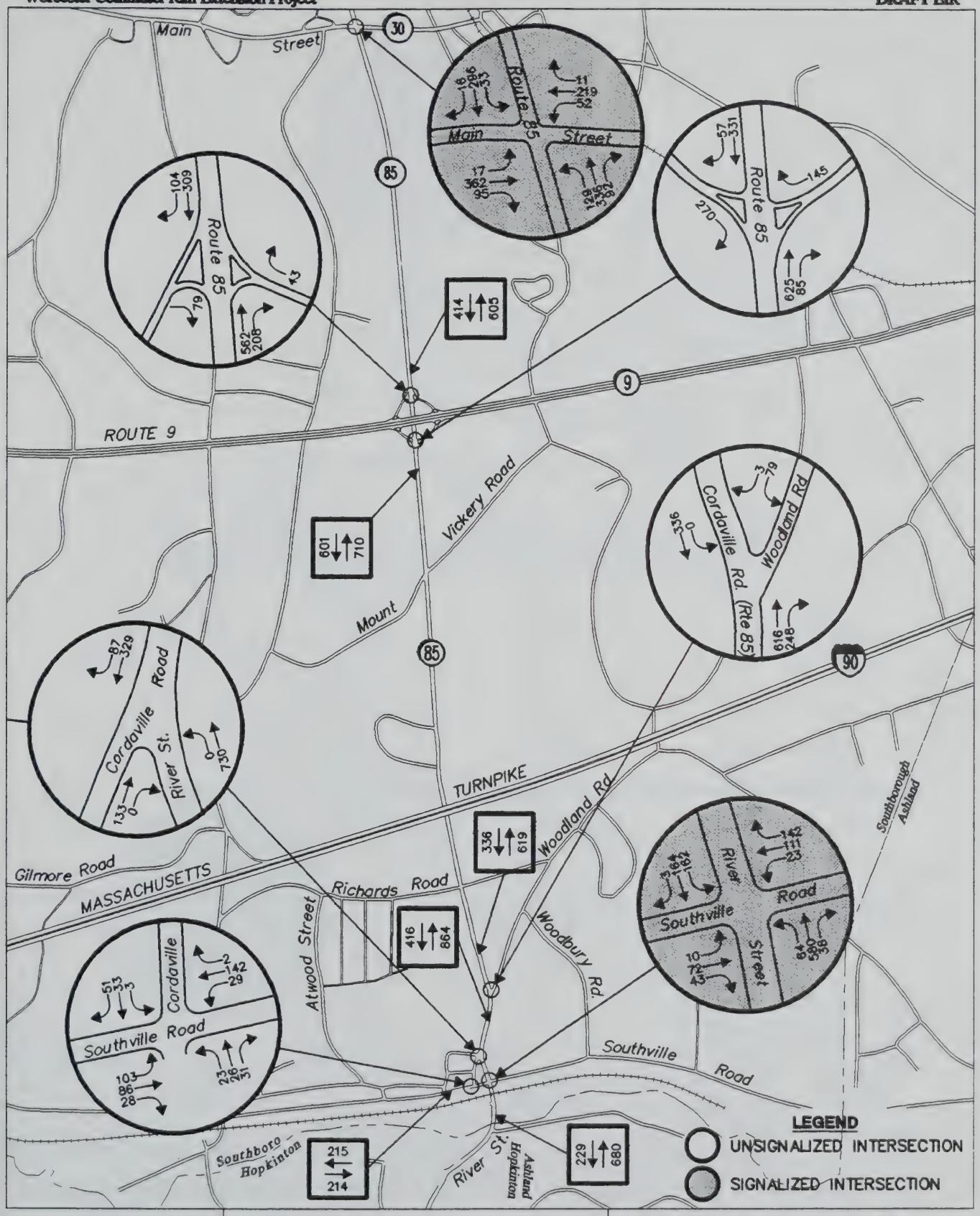
By the year 2001, there is expected to be some minor shifting in the origins of the commuters utilizing the station from the 1996 conditions. The Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension in the year 2001. CTPS projected that a total of 2,299 persons are expected to utilize the railroad for daily round trip commuting into Boston. The proposed Southborough Station is anticipated to attract a total of 553 of these daily round trip commuters. A total of 83 of these commuters would be dropped off at the station. Based upon an average automobile occupancy rate of 1.12, the approximately 470 Park'n'Ride patrons would result in a parking demand of 420 spaces. This is the capacity of the proposed parking lot.

These patrons are projected to reside in the Towns of Hopkinton, Marlborough, Southborough, Upton and Westborough. Due to the stations proposed location, no riders are projected to walk to the station. The number of patrons who originate from each Town are shown in Table 1.7-22. The ridership has been revised to reflect peak period usage, which is 94% of total daily demand.

Table 1.7-22 Projected Patrons of Southborough Station Year 2001

Town	Riders*
Hopkinton	89
Marlborough	218
Southborough	88
Upton	71
Westborough	53
TOTAL	**519**

* *Adjusted for peak period usage*



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±
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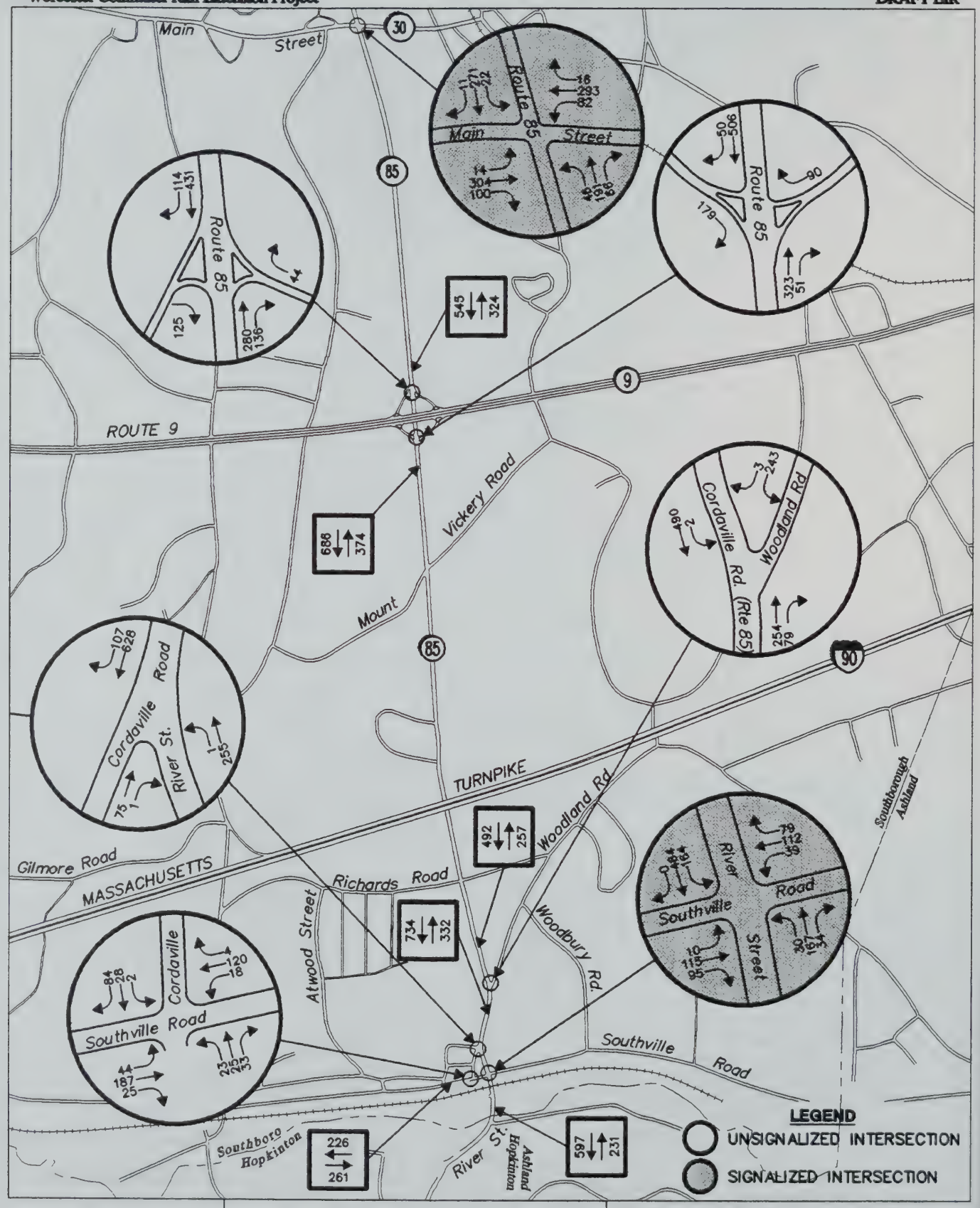
A.M. Peak Generator Hour
7:00 - 8:00 A.M.
2001 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-22



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
2001 NO BUILD
SOUTHBOROUGH STATION

FIGURE 1.7-23

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, of even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier of later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The distribution of ridership per train is the same as under the 1996 conditions.

Table 1.7-23 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.7-23 MBTA Ridership Distribution - Southborough Station

Inbound Train	Patrons
502A	102
504A	168
506A	169
510	80
TOTAL	**519**
Outbound Train	**Patrons**
515A	73
519	120
521	120
521A	180
523	26
TOTAL	**519**

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Southborough would utilize a variety of travel routes, depending on the location of their residence. Due to the minor shifts in town of origin of the patrons addressed previously, the percentage of site generated traffic on the study area roadways is slightly different than under the 1996 conditions.

Patrons from Hopkinton and Upton would access the station from Cedar Street (Route 85). Patrons from Westborough would access the station from either Route 9 to Route 85, or by Flanders Road to Southville Road. Commuters from Marlborough would access the station from Route 85.

Figure 1.7-24 shows the percentage of station related traffic utilizing the study area roadways.

Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

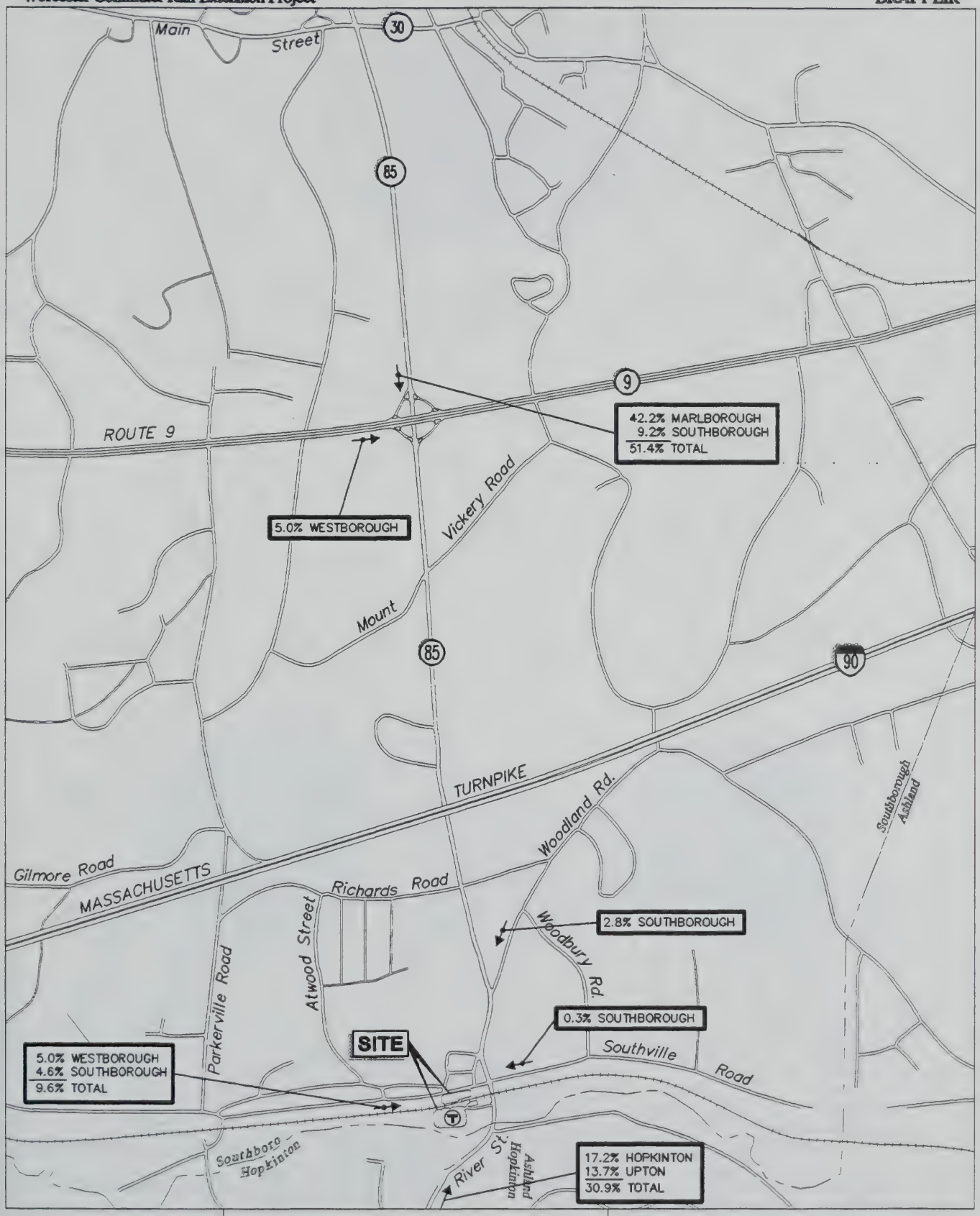
- The projected year 2001 "No Build" traffic volumes.
- Traffic specifically generated by the proposed Southborough rail station.

A portion of the traffic volumes accessing the proposed station would be diverted from traffic travelling on Route 85, not generated as completely new trips. One of the primary access routes for commuters from Hopkinton and Upton travelling to Boston is from Route 85 to Route 9. This traffic pattern currently carries these vehicles past the proposed station location. This traffic is referred to as "by-pass" traffic. Typically, 100% of this by-pass traffic would be subtracted from the respective "No Build" traffic volumes to avoid double counting these vehicles in the "Build" analysis. Since other travel routes exist, a conservative 50% adjustment was applied. Fifty percent of the traffic generated hourly by the commuter rail station from the towns of Hopkinton and Upton was subtracted from the 2001 "No Build" traffic volumes along Route 85 northbound to Route 9 eastbound in the A.M. peak hour. This same principle applies to these vehicles for the evening return trip. To adjust for the by-pass traffic for the P.M. peak hour, 50% of the traffic generated hourly by the commuter rail station from Hopkinton and Upton was subtracted from Route 9 westbound to Route 85 southbound.

Figures 1.7-25 and 1.7-26 show the A.M. and P.M. peak roadway hour traffic volumes, respectively. Figures 1.7-27 and 1.7-28 show the A.M. and P.M. peak generator hour volumes.

Year 2001 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing and 1996 "No Build" conditions were analyzed under the 2001 "No Build" and "Build" conditions. This assumes that the analysis was performed using the "all else being equal" assumption. The traffic volumes are the only parameter in the analysis to



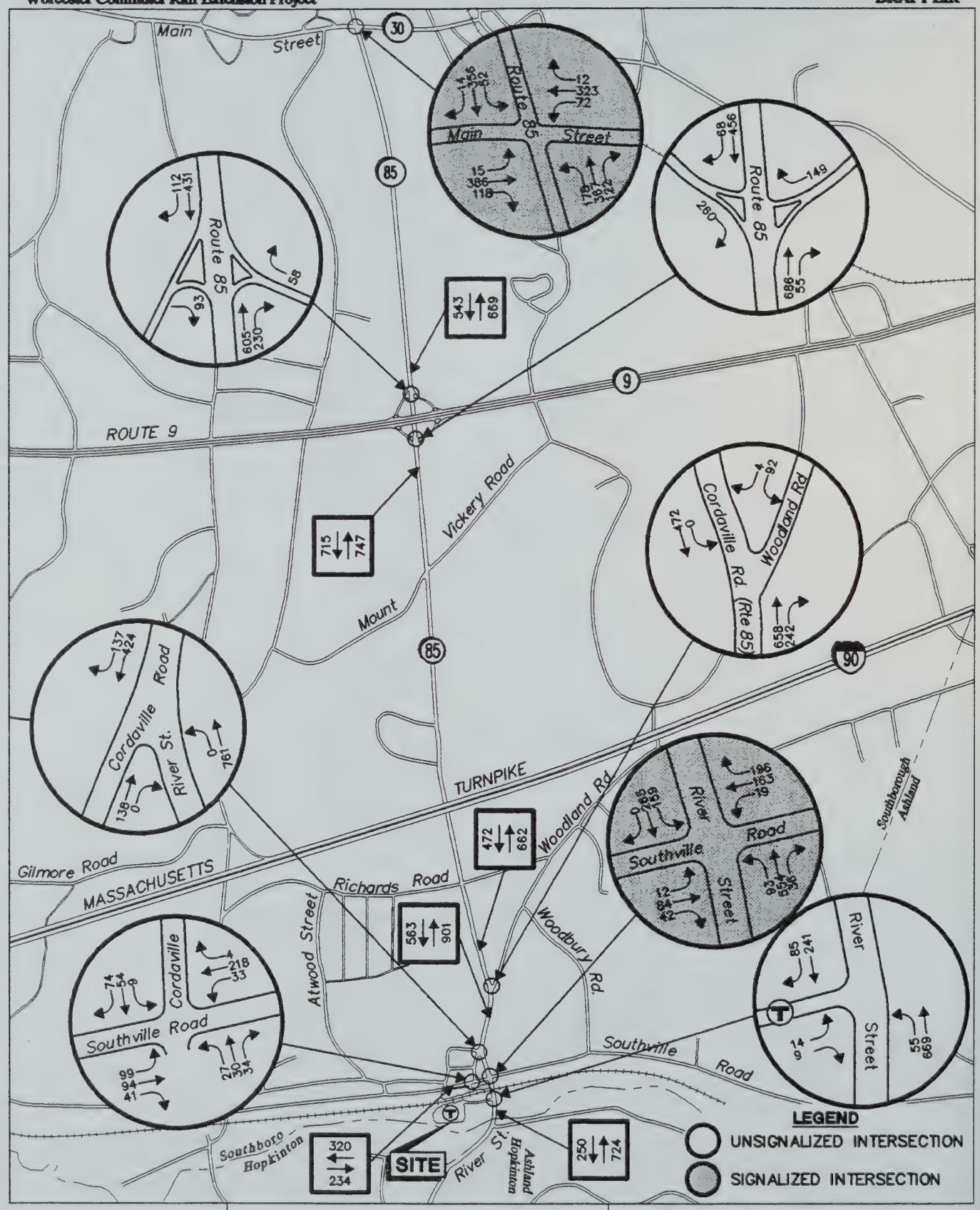
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-24



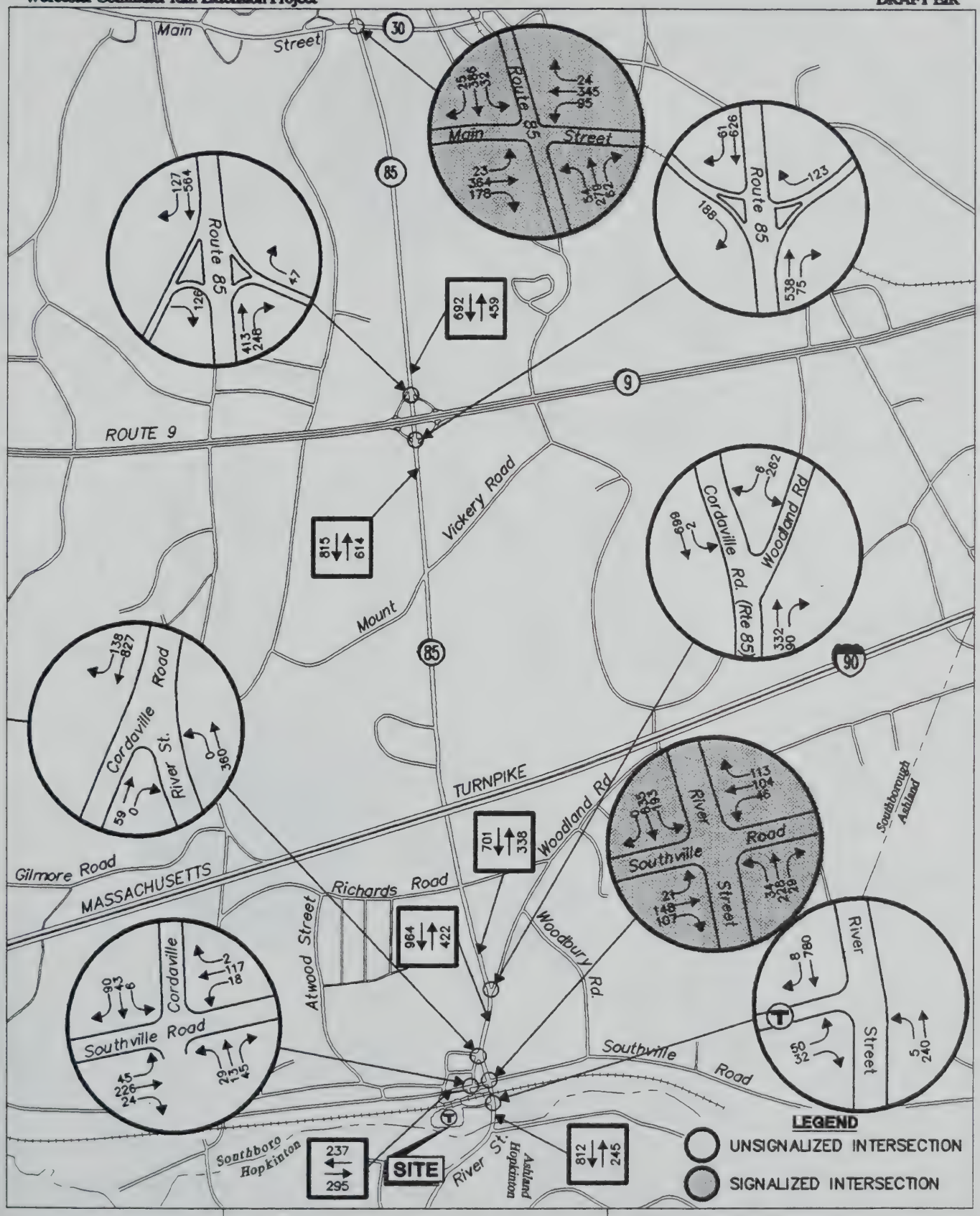
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-25



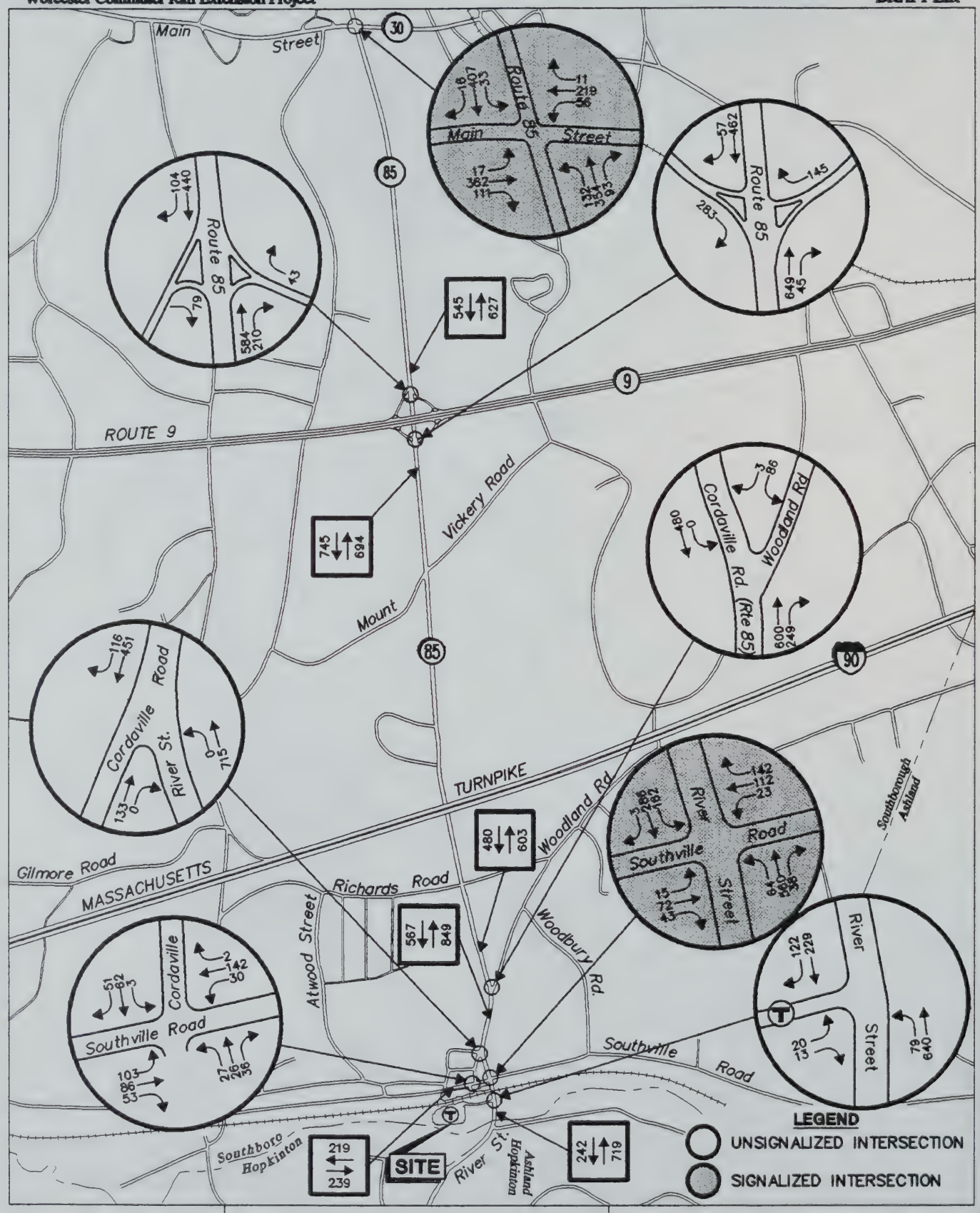
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Hour
4:45 - 5:45 P.M.
2001 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-26



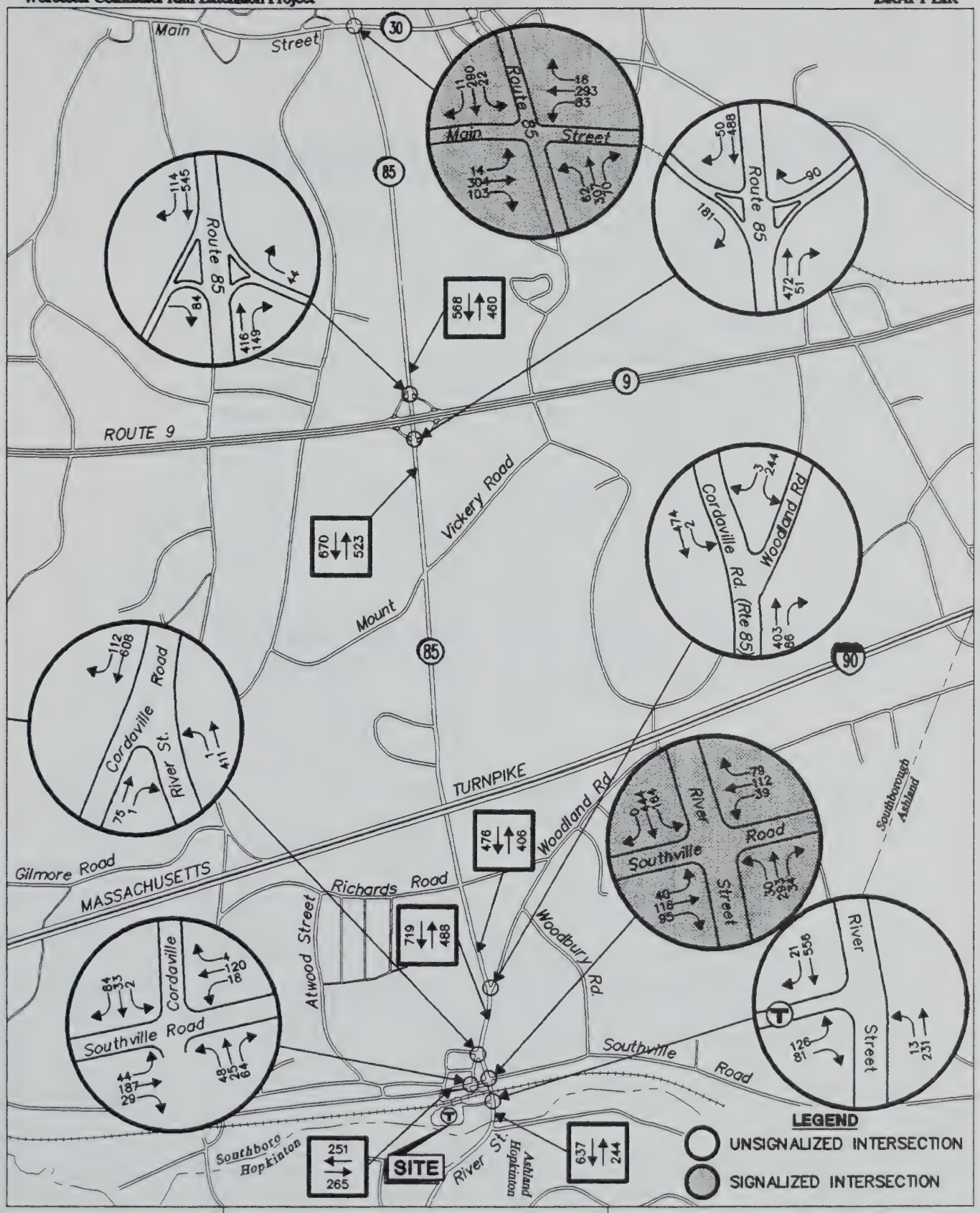
Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

A.M. Peak Generator Hour
7:00 - 8:00 A.M.
2001 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1"=1750'±

0 1750

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
2001 BUILD ALL STATIONS
SOUTHBOROUGH STATION

FIGURE 1.7-28

change from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 2001 "No Build" Condition were not changed from the existing conditions. For the 2001 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.7-24 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 2001 "No Build" and "Build" conditions.

As shown in the table, the Southville Road/River Street intersection operates at an overall unacceptable LOS "F" during both the A.M. and P.M. peak hours for the "No Build" condition. The Southbound approach of River Street at Southville Road operates at an unacceptable LOS "F" during both the A.M. and P.M. peak hours. The northbound approach of River Street at Southville Road also operates at LOS "F" for the A.M. and P.M. peak hour. These unacceptable LOS ratings are largely due to the timings set in the controller. The analysis for the "Build" condition was performed utilizing optimal timings. This resulted in acceptable LOS ratings for the overall intersection and on all individual approaches; the westbound and southbound approaches will operate at LOS "E" in the A.M. peak hour.

As shown in the table under the "No Build" condition the Cordaville Road/Main Street intersection is expected to operate at an unacceptable overall level of service (LOS "F") during the A.M. peak hour and an acceptable level of service (LOS "D") in the P.M. peak hour. The northbound movement will operate at LOS "F" in the A.M. peak hour while the westbound movement will operate at LOS "F" in the P.M. peak hour. Under the "Build" condition the intersection will continue to operate at LOS "F" in the A.M. peak hour and at acceptable LOS "C" in the P.M. peak hour. During the A.M. peak hour both the westbound and northbound movements will operate at LOS "F". All movements operate at acceptable levels of service during the P.M. peak hour.

Table 1.7-24 2001 Peak Hour Signalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	F(108.4)	D(33.8)	C(19.0)
Eastbound	B(9.2)	B(10.4)	C(21.3)	C(24.5)
Westbound	B(12.5)	B(10.8)	E(56.6)	D(33.2)
Northbound	F*	F(65.3)	C(15.2)	B(5.9)
Southbound	F*	F*	E(44.7)	C(17.5)
Cordaville and Main	F(63.5)	D(37.2)	F*	C(20.1)
Eastbound	C(16.0)	C(20.3)	D(27.8)	B(13.6)
Westbound	D(25.1)	F(100.3)	F*	D(25.4)
Northbound	F*	B(12.6)	F*	D(25.6)
Southbound	C(18.4)	B(12.5)	C(18.3)	C(18.0)

LOS (Average Vehicle Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 2001 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak hour analysis for the year 2001 "No Build" and "Build" conditions are listed in Table 1.7-25.

All of the unsignalized intersections are operating at good levels of service under the "No Build" and "Build" conditions for the A.M. and P.M. peak hours, with two exceptions. The left and right turns from Woodland Road to Cordaville Road operate at LOS "F" in the P.M. for both the "No Build" and "Build" conditions. The left and right turns from Cordaville Road to River Street receive a LOS "F" under both conditions in the morning peak, and LOS "E" during the P.M. peak.

Table 1.7-25 2001 Peak Hour Unsignalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southern Lot				
LT from NB River	-	-	A(744)	A(460)
LT and RT from Southern Lot	-	-	C(203)	D(121)
	-	-		
Southville and Cordaville				
LT from EB Southville	A(819)	A(982)	A(819)	A(982)
LT from WB Southville	A(996)	A(877)	A(977)	A(876)
All from Northern Lot	B(396)	A(462)	B(366)	B(427)
All from Cordaville	A(478)	A(568)	A(418)	A(560)
Cordaville and River				
LT from NB River	A(694)	B(368)	A(613)	B(371)
LT and RT from Cordaville	F(-20)	E(54)	F(-38)	E(42)
Cordaville and Woodland				
LT from SB Cordaville	B(398)	A(772)	A(403)	A(719)
LT and RT from Woodland	E(30)	F(-109)	E(5)	F(-124)
NB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	B(310)	A(468)	B(308)	A(425)
SB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	A(437)	C(300)	B(355)	B(303)
NB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(408)	A(577)	A(402)	A(535)
SB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(594)	B(382)	A(521)	B(393)

LOS (Reserve Capacity - Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.7-26 lists the results of this analysis for the A.M. and P.M. peak roadway hours. Although most

of the segments are classified as LOS "E" for both the "Build" and "No Build" conditions, it should be noted that all roadway segments operate within the acceptable range of reserve capacity under both the "No Build" and "Build" conditions.

Table 1.7-26 2001 Peak Hour Road Segment Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River South of Site	E(1105)	E(955)	E(1066)	E(932)
Southville West of Site	D(1633)	C(1781)	D(1625)	C(1781)
Cordaville North of River	E(687)	E(691)	E(662)	E(676)
Cordaville North of Woodland	E(1076)	E(1061)	E(1071)	E(1069)
Cordaville South of Route 9	E(814)	E(807)	E(794)	E(794)
Cordaville North of Route 9	E(1043)	E(1078)	E(987)	E(1047)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generator hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.7-27 for the 2001 "No Build" and "Build" conditions.

Under the "No Build" condition, the intersection of River Street and Southville Road was found to operate at an unacceptable level of service during the A.M. peak generator hour and at a LOS "E" in the P.M. peak period. The northbound approach operates at LOS "F" during the A.M. hour, while the southbound approach operates at LOS "F" during both the A.M. and P.M. hours. Under the "Build" condition using optimized timing the intersection was found to operate at acceptable levels of service in both the A.M. and P.M. peak generator hours. However, both the westbound and southbound approaches are expected to operate at LOS "E" in the A.M. peak generator hour.

Under the "No Build" condition the Cordaville Road/Main Street intersection was found to operate at a level of service (LOS "E") in the A.M. peak generator hour and an acceptable level of service (LOS "C") in the P.M. peak generator hour. Only the northbound approach in the A.M. hour is expected to operate at LOS "F". All other approaches will operate with acceptable levels of service. Under the "Build"

condition the overall level of service for the A.M. peak generator hour will deteriorate to LOS "F" with both the northbound and westbound approaches also functioning at LOS "F". During the P.M. peak generator hour the intersection and all individual movements will operate at acceptable levels of service.

Table 1.7-27 2001 Peak Generator Hour Signalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southville	F*	E(44.6)	D(29.3)	B(12.3)
Eastbound	B(9.1)	B(9.8)	D(27.1)	C(20.8)
Westbound	B(10.8)	B(10.4)	E(57.3)	C(21.2)
Northbound	F(104.5)	B(14.4)	B(8.1)	B(5.7)
Southbound	F*	F(78.7)	E(40.6)	B(9.9)
Cordaville and Main	E(50.4)	C(16.3)	F*	C(15.7)
Eastbound	C(15.9)	B(14.0)	D(30.7)	B(12.2)
Westbound	D(26.4)	D(27.0)	F*	C(17.9)
Northbound	F*	B(11.2)	F*	C(19.3)
Southbound	B(14.2)	B(10.8)	C(21.8)	B(13.2)

LOS (Average Vehicle Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

Results of the A.M. and P.M. generator peak hour analysis are listed in Table 1.7-28.

Again, as with the peak hour analysis, all of the intersection movements operate at acceptable levels of service under the "No Build" and "Build" conditions for the A.M. and P.M. peak generator hours with the exception of two. The left and right turns from Woodland Avenue to Cordaville Road are rated LOS "E" for the "Build" and "No Build" conditions in the A.M. peak hours. The turns receive a LOS "F" in the P.M. "Build" condition. The left and right turns from Cordaville Road to River Street operate at a LOS "E" in the A.M. "No Build" condition. In the P.M. "No Build", they operate at LOS "D". For the "Build" condition, they decline to LOS "F" and "E" for the A.M. and P.M., respectively.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.7-29 lists the results of this analysis for the A.M. and P.M. peak generator hours.

As shown in the table, many of the roadway segments operate at LOS "E" for the "No Build" and "Build" conditions. However, all roadway segments operate within the range of acceptable reserve capacity.

Table 1.7-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River and Southern Lot				
LT from NB River	-	-	A(701)	A(589)
LT and RT from Southern Lot	-	-	D(190)	E(85)
Southville and Cordaville				
LT from EB Southville	A(896)	A(978)	A(896)	A(978)
LT from WB Southville	A(1003)	A(913)	A(976)	A(909)
All from Northern Lot	A(479)	A(470)	A(437)	A(403)
All from Cordaville	A(579)	A(644)	A(483)	A(622)
Cordaville and River				
LT from NB River	A(726)	A(495)	A(609)	A(505)
LT and RT from Cordaville	E(3)	D(111)	F(-25)	E(69)
Cordaville and Woodland				
LT from SB Cordaville	A(422)	A(796)	A(431)	A(665)
LT and RT from Woodland	E(63)	E(0)	E(25)	F(-53)
NB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	B(341)	A(639)	B(339)	A(518)
SB Cordaville and EB Ramps				
RT from Route 9 EB Ramp	A(439)	A(401)	B(319)	A(412)
NB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(450)	A(688)	A(436)	A(571)
SB Cordaville and WB Ramps				
RT from Route 9 WB Ramp	A(641)	A(491)	A(535)	A(515)

LOS Reserve Capacity - Vehicles

Table 1.7-29 2001 Peak Generator Hour Road Segment Level of Service

Southborough	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
River South of Site	E(1080)	D(1252)	E(1024)	D(1195)
Southville West of Site	C(1876)	C(1846)	C(1816)	C(1858)
Cordaville North of River	E(803)	E(1028)	E(743)	E(987)
Cordaville North of Woodland	E(1162)	D(1384)	E(1141)	D(1410)
Cordaville South of Route 9	E(917)	E(1082)	E(810)	E(1060)
Cordaville North of Route 9	E(1124)	D(1301)	E(1057)	E(1238)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

Year 2001 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.7-30 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. roadway peak hours for the intersections and road segments analyzed.

As shown in the table, the intersection of the site driveway from the southern lot with River Street is expected to exceed the ten percent criteria during the A.M. peak hour, as is the segment of Cordaville Road north of Woodland Road.

Table 1.7-30 2001 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Cordaville and Main	5.3%	3.4%
River and Southern Lot	15.2%	8.5%
River and Southville	6.2%	4.2%
Southville and Northern Lot	6.1%	4.0%
Cordaville and River	8.4%	5.2%
Cordaville and Woodland	8.3%	4.2%
Cordaville and Route 9 East Ramps	6.9%	3.4%
Cordaville and (Route 9) West Ramps	7.0%	3.5%
Roadway Segment		
Southville West of North Lot	3.6%	2.3%
River South of Southern Lot	6.6%	3.5%
Cordaville North of River	8.3%	5.2%
Cordaville North of Woodland	10.2%	6.6%
Cordaville South of Route 9	7.9%	4.8%
Cordaville North of Route 9	8.7%	5.5%

Site generated traffic as a percentage of total traffic

Construction Impacts of Replacing Railroad Bridge

The construction method for replacing the railroad bridge over Route 85 has not yet been determined. Construction is anticipated to last for approximately ten months. While traffic delays are inevitable, the work will be sequenced to minimize the impacts.

Summary of Findings

Generally, the streets and intersections in the Southborough study area function at acceptable levels of service for both the "No Build" and "Build" conditions. However, some locations operate unacceptably during certain peak periods under both conditions.

The River Street/Southville Road intersection operates unacceptably in the "No Build" condition. However, with proper signal timing the intersection will function efficiently with acceptable levels of service.

The Cordaville Road/Main Street intersection while operating at acceptable levels in 1996, is expected to deteriorate to unacceptable levels during the A.M. peak periods in 2001. It appears this is due to normal traffic growth and will occur with or without the commuter rail station.

Traffic turning from Cordaville Road to River Street and traffic turning from Woodland Road to Cordaville Road experience unacceptable levels of service under both "No Build" and "Build" conditions. The Town of Southborough has expressed a desire to make improvements at these locations in conjunction with the commuter rail project.

Proposed mitigation and mitigation options in Southborough are discussed in Section 15.12 of this DEIR.

1.8 Ashland Station-East

Project Introduction

The proposed location for the Ashland Commuter Rail Station is between Pleasant Street and the existing Conrail tracks and between the existing Conrail tracks and Megunko Road. There will be two parking lots. One north of the Conrail tracks with access to Pleasant Street and one south of the tracks with access to Union Street. It is proposed that the total parking be approximately 700 parking spaces with 200 in the northern parking lot and 500 in the southern parking lot. This arrangements should eliminate the need for traffic to cross the Conrail tracks on Main Street or Cherry Street to access the stations parking lots.

This site is one of two sites selected by both the MBTA and a citizen committee established by the Ashland Board of Selectmen after a review of 8 to 10 potential sites. This location was chosen based on its potential parking capacity, availability of vacant land, proximity to major access roadways, joint development potential and the minimal potential for environmental and neighborhood impacts.

The proposed station will consist of two 800 foot long low level platforms with 45 foot long mini-high platforms for handicapped access, a pedestrian overpass, a drop-off area for Kiss 'n' Ride patrons in each parking lot, adequate lighting for public safety and landscaping.

Study Area

The study area for assessment of traffic impacts at this station is focused on roadways which are anticipated to be used as the major access routes. These roadways include:

- Pleasant Street
- Oak Hill Road (Southborough)
- Oak Street
- Cordaville Road
- Southville Road (Southborough)
- Union Street (Route 135)
- Summer Street
- Cherry Street
- Main Street

Most of these roadways are maintained by the Town of Ashland. Cordaville Road is an unnumbered route maintained by the State. Oak Hill Road and Southville Road are located in Southborough and maintained by the Town of Southborough.

Most of these roadways are two lane facilities with at-grade intersections controlled by stop signs or traffic signals. These roadways serve a mixture of light industrial, commercial, retail and residential land uses. Truck travel is restricted along Myrtle Street between Main Street and the Framingham Town line. Trucks over 2.5 tons are prohibited. A designated truck route exists for access between the town center and Route 9. This route includes Pleasant Street, Cordaville Road, Oak Street and Route 9.

Two at-grade railroad crossings exist which require analysis. The existing railroad tracks cross Cherry Street and Main Street, east of the proposed station site. Currently, Amtrak and Conrail utilize the line. Additional commuter trains destined to and from Boston during peak travel periods will necessitate more frequent stoppages of traffic on both Main Street and Cherry Street.

Data Collection

To assess the existing transportation environment, a data collection program was performed from October to December of 1992. These counts were supplemented by counts made in June of 1994. Data items necessary for analysis of operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing and timing, and geometric configuration of roadway links and intersections.

Intersection turning movement counts were performed at the following intersections:

- Pleasant Street with Main Street
- Pleasant Street with Tilton Avenue
- Pleasant Street with High Street
- Main Street with Front Street
- Main Street with Summer Street and Homer Avenue
- Cherry Street with Tilton Avenue
- Cherry Street with Summer Street
- Union Street with Main Street
- Union Street with Summer Street

Vehicle turning movements at these intersections were observed and recorded from 6:30 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the roadway peak hour volumes, and the volumes during the projected commuter rail station peak generator hours.
The turning movement counts used to obtain the traffic volumes used in the existing conditions level of service analysis were made at the following intersections on the following dates:

	A.M.	P.M.
Pleasant with High	6-23-94	6-23-94
Pleasant with Tilton	11-12-92	11-10-92
Pleasant with Main	11-10-92	10-20-92
Cherry with Tilton	12-2-92	12-1-92
Main with Front	10-8-92	10-1-92
Main with Summer and Homer	12-8-92	12-2-92
Cherry with Summer	12-1-92	11-24-92
Union with Summer	6-8-94	6-8-94
Union with Main	6-14-94	6-14-94

Vehicles were classified into two categories: cars, and trucks or buses. Volumes were recorded in 15 minute intervals to allow determination of the peak hour, and calculation of peak hour factors. The 1992 peak hour traffic volumes are shown on Figures 1.8-1 and 1.8-2 for the A.M. and P.M. peak hours respectively. Since peak generation hours for the station's traffic may not coincide with standard peak hours, it is also necessary to analyze the A.M. and P.M. peak generator hours. The 1992 site peak generator hours are shown on Figures 1.8-3 and 1.8-4 for the A.M. and P.M. peak hours respectively.

Traffic signal timing is required for analysis of signalized intersection operations. The existing traffic signals within the study area are traffic actuated. Phasing and timing of actuated signals were obtained from the Town of Ashland Highway Department.

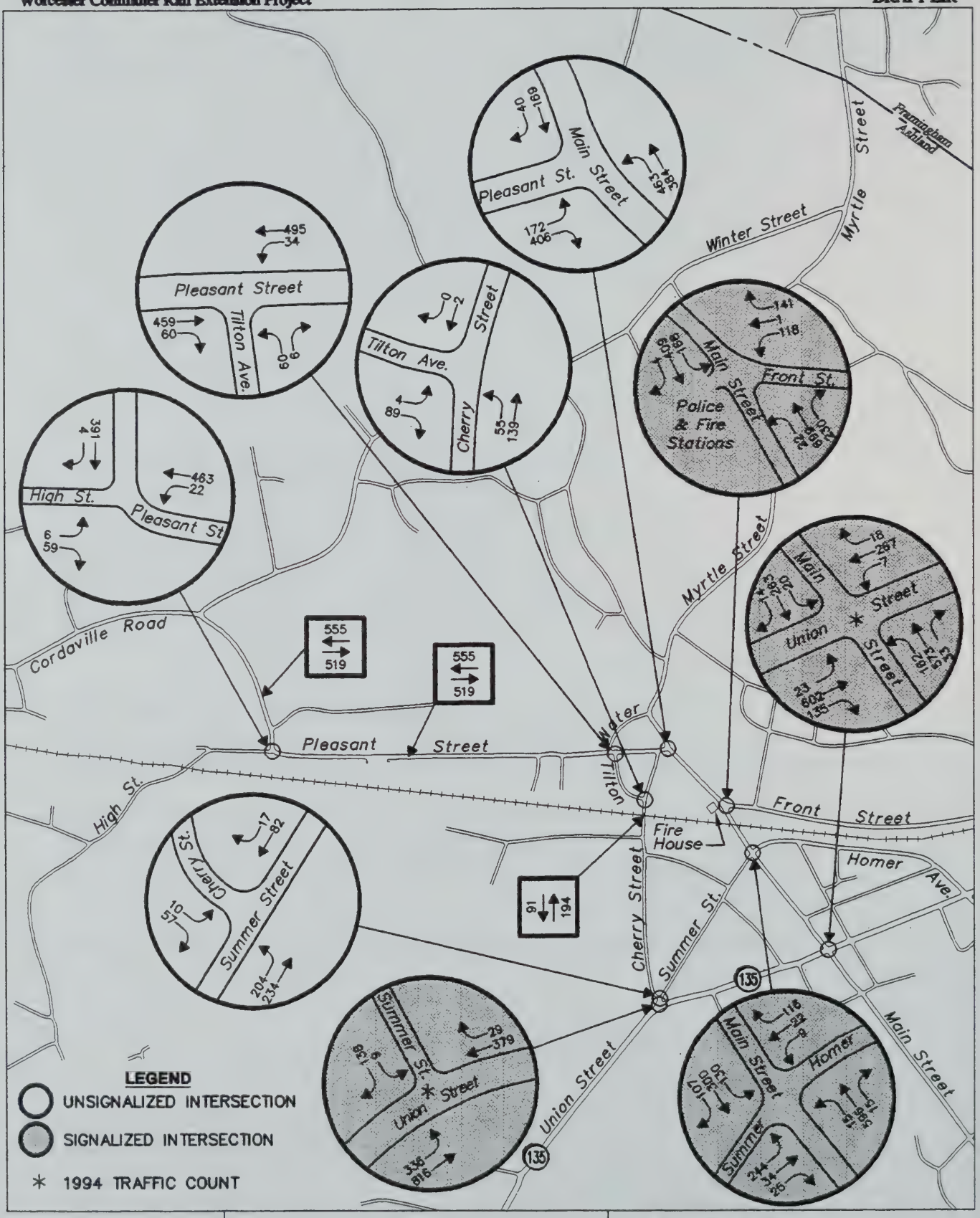
Intersection geometric configurations were determined through field observations. Geometric elements such as number and use of travel lanes, lane widths, and roadway grades are required for analysis of operational conditions and were observed in the field.

The field data sheets for the counts are available for review at the MBTA and MEPA Office.

Year 1992 Existing Conditions

Signalized Intersections

The existing signalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209*, (HCM). The micro-computer software package "CINCH", developed by Central Transportation Planning Staff (CTPS) was used for the intersection analysis. The computerized outputs of "CINCH" can be found in a report available at the MBTA and MEPA. This program automates the analysis procedures of the HCM.



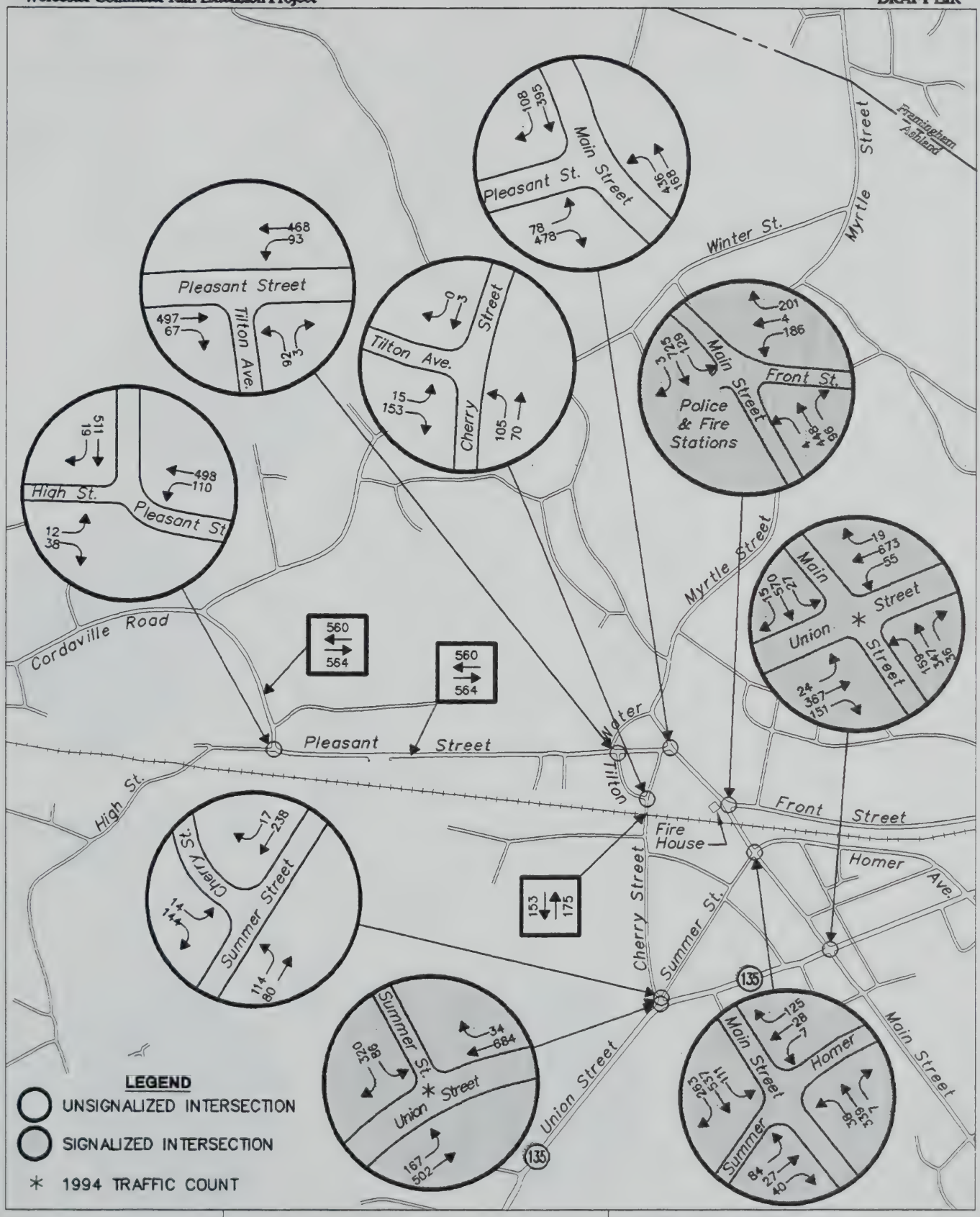
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1992 Existing Conditions
ASHLAND STATION-EAST

FIGURE 1.8-1



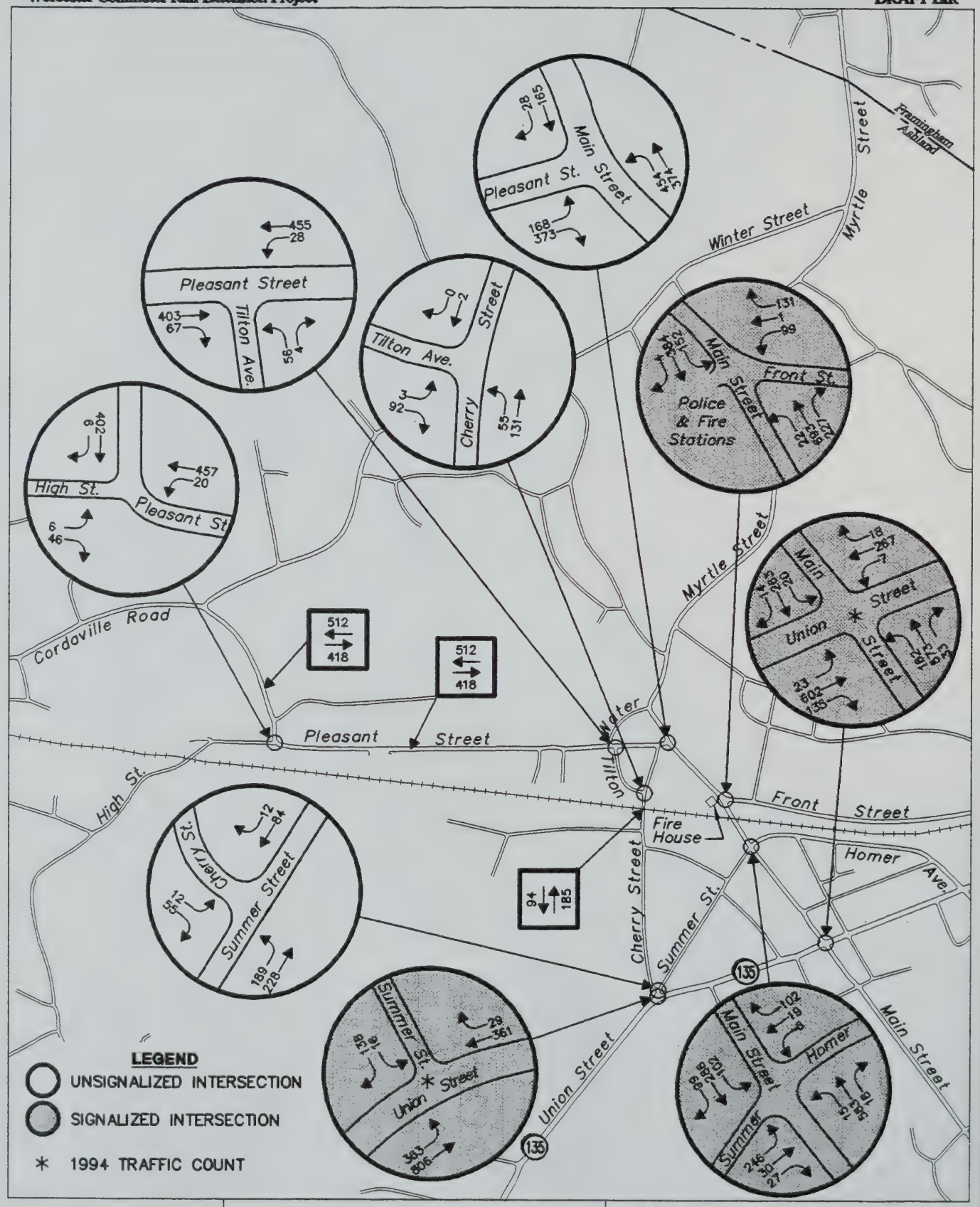
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1992 Existing Conditions
ASHLAND STATION-EAST

FIGURE 1.8-2

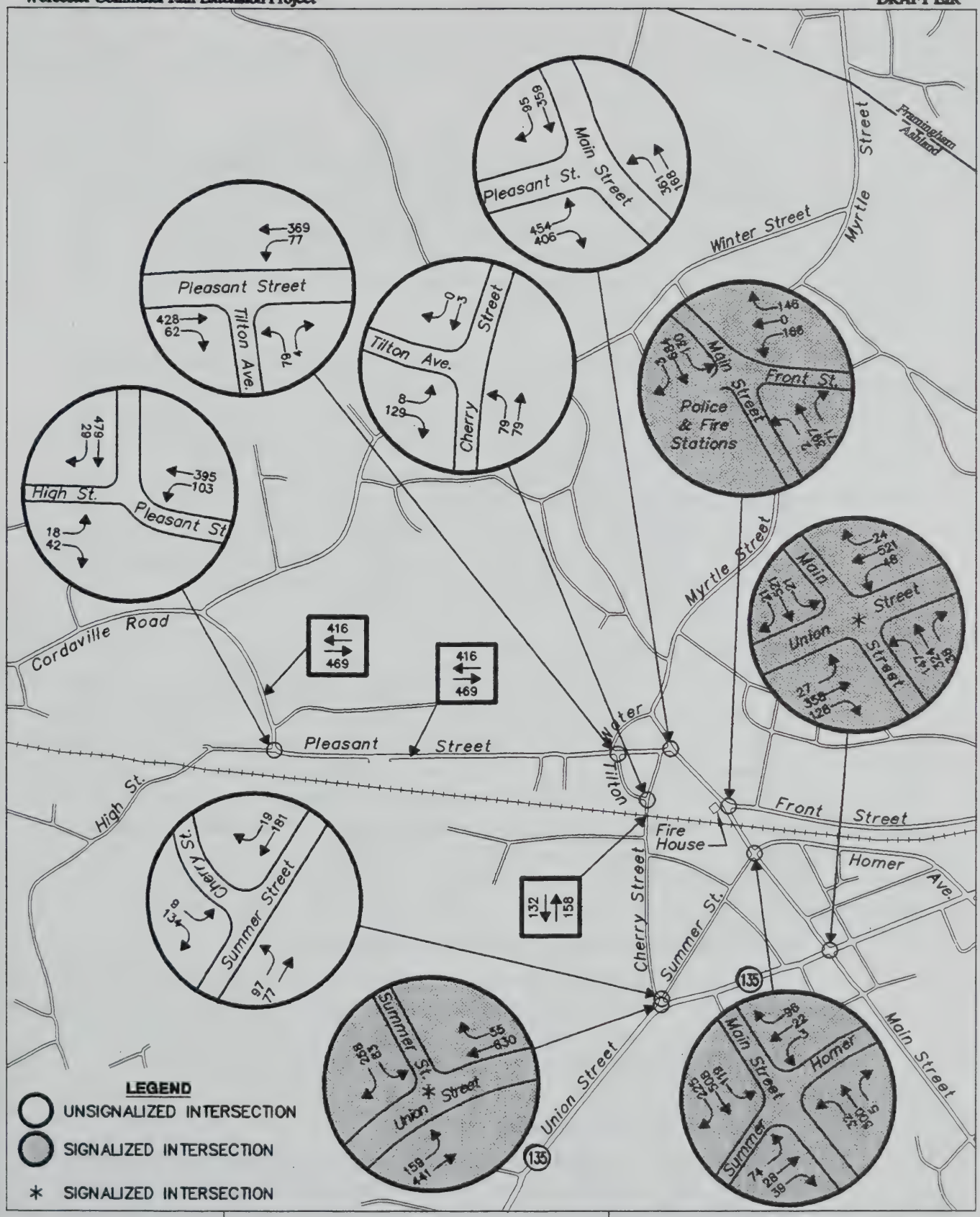


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1992 Existing Conditions
ASHLAND STATION-EAST

FIGURE 1.8-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1992 Existing Conditions
ASHLAND STATION-EAST

FIGURE 1.8-4

The analysis is based on various parameters such as intersection geometrics, traffic volumes and movements, traffic signal timing, vehicle mix, etc. The average length of time that a vehicle is sitting stationary at the intersection, known as average vehicle stopped delay, is determined and used to categorize the level of service (LOS) of the intersection. LOS ranges from a virtual free flowing condition "A", to congestion and high stopped delays "F". A detailed description of level of service is presented in Section 1.1 of this report.

The approach capacities were decreased for most approaches for the intersections of Main Street with Front Street and Main Street with Summer Street and Homer Avenue to account for the effects of the at-grade railroad crossing adjacent to these intersections. The periodic gate closings effectively reduce intersection capacity proportional to the length of the closing. Roadway operations at the grade crossing are controlled by the level of service at the two adjacent signalized intersections. A complete explanation of the methodology used to adjust intersection capacity at railroad grade crossings is provided in Section 1.1 of this Appendix. Four signalized intersections were analyzed and include the following:

Main Street/Front Street Intersection

The intersection of Front Street with Main Street is a "T" intersection located in the Commercial-B district in Ashland center just north of the railway grade crossing on Main Street. The intersection is controlled by a traffic actuated signal. The entrance driveway to the police and fire stations is located opposite Front Street. This intersection, along with the Main Street/Summer Street and Homer Avenue intersection, was chosen to analyze the impacts to Main Street due to the additional railroad gate closings. Front Street is an east-west two lane, two way collector roadway. Main Street is a north-south two lane, two way arterial roadway.

Main Street/Summer Street and Homer Avenue Intersection

This cross road intersection is located just south of the railway grade crossing at Main Street in the Commercial-B district of Ashland center. It is controlled by a traffic actuated signal. Summer Street and Homer Avenue are two lane, two way collector roads. Main Street is a two lane, two way arterial roadway.

Main Street/Union Street Intersection

This cross road intersection is located south of the Main Street/Summer Street and Homer Avenue Intersection in the Commercial-B district of Ashland Center. It is controlled by a traffic actuated signal. Main Street is a two lane, two way arterial roadway. Union Street is a two lane, two way undivided state highway (Route 135).

Union Street/Summer Street Intersection

This "T" intersection is located west of the Main Street/Union Street intersection in the Commercial-B district of Ashland Center. It is controlled by a traffic actuated signal. Union Street is a two lane, two way undivided state highway (Route 135). Summer Street is a two lane, two way collector road connecting Union Street and Main Street.

Table 1.8-1 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours. The peak generator hour for the commuter rail station is also shown and is the hour that usage of the rail station will be heaviest. The table shows the overall LOS rating for the intersection as well as each movement, and the average vehicle stopped delay, in seconds. Signalized intersections may be assigned an overall LOS rating as well as a LOS rating for the individual approaches. As shown in the table, the Main Street/Front Street and Main Street/Summer Street intersections operate at acceptable overall levels of service during both the A.M. and P.M. peak hours. During the A.M. peak hour the northbound approach to Main Street at Front Street, and the southbound approach to Main Street at Summer Street operate at LOS "E", while the eastbound approach to Summer Street at Main Street operates at an unacceptable LOS "F". During the P.M. peak hour, the southbound approach of Main Street at Front Street operates at low LOS "E".

The Main Street/Union Street intersection is at LOS "E" in the A.M. peak hour while the Union Street/Summer Street intersection operates at unacceptable LOS "F" in both the A.M. and P.M. peak hours. The eastbound approach to the Main Street/Union Street intersection is at LOS "F" in the A.M. peak hour and in the P.M. peak hour the westbound approach is at LOS "E". At the Union Street/Summer Street intersection, the eastbound and westbound approaches are LOS "F" in the A.M. peak hour while the westbound and southbound approaches function at LOS "F" in the P.M. peak hour.

Table 1.8-1 1992 Existing Signalized Intersection Level of Service

Ashland-East	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Main and Front	D(29.1)	D(33.3)	D(30.0)	C(24.0)
Westbound	C(23.2)	D(25.2)	C(22.8)	D(25.2)
Northbound	E(43.2)	C(15.6)	E(44.0)	B(13.8)
Southbound	B(8.9)	E(46.6)	B(8.1)	D(29.2)
Main and Summer	D(34.5)	B(13.5)	D(30.1)	B(14.8)
Eastbound	F(61.8)	C(18.9)	F(77.1)	C(18.3)
Westbound	C(17.1)	C(17.0)	C(16.6)	C(16.6)
Northbound	B(12.6)	B(7.8)	B(12.7)	B(7.4)
Southbound	E(49.7)	B(14.4)	D(26.8)	C(16.9)
Main with Union	E(45.2)	D(26.8)	E(45.2)	C(18.7)
Eastbound	F(106)	C(17.1)	F(106)	C(16.1)
Westbound	B(7.9)	E(54.4)	B(7.9)	D(31.1)
Northbound	C(15.2)	B(11.7)	C(15.2)	B(9.9)
Southbound	B(7.2)	C(15.5)	B(7.2)	B(14.2)
Union with Summer	F*	F*	F*	F*
Eastbound	F*	B(13.5)	F*	B(12.9)
Westbound	F(63.3)	F*	F(60.4)	F*
Southbound	B(14.2)	F(61.5)	B(14.2)	E(40.3)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

The results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.8-1. As shown, the Main Street/Front Street intersection, the Main Street/Summer Street intersection and the Main Street/Union Street intersection all have acceptable overall levels of service in the peak generator hours. The northbound Main Street approach at Front Street is at LOS "E" in the A.M. generator hour. The eastbound Summer Street approach to Main Street and the eastbound Union Street approach to Main Street are at LOS "F" in the A.M. generator hour. The Union Street/Summer Street intersection is at LOS "F" during both peak generator hours. The eastbound approach operates at LOS "F" in the A.M. generator hour while

the westbound approach operates at LOS "F" in both the A.M. and P.M. generator hours.

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The software program "CINCH" was used to perform the analysis. The computerized outputs of "CINCH" can be found in an uncirculated report available at the MBTA and MEPA. As with the signalized intersections, A.M. and P.M. analysis was performed for both the intersection peak hour and the site peak generator hour.

As opposed to the signalized intersection results, levels of service for unsignalized intersections are stated in terms of reserve capacity for a particular movement only. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. A detailed description of level of service is provided in Section 1.1 of this report.

Five unsignalized intersections were analyzed and include the following:

Cherry Street/Tilton Avenue Intersection

The intersection of Cherry Street and Tilton Avenue is a "T" intersection located north of the at-grade railroad crossing on Cherry Street and bordered by Residential-B, Industrial, and Commercial-B districts. Cherry Street is a north-south subcollector carrying traffic in two lanes between Summer Street and Tilton Avenue. At Tilton Avenue Cherry Street becomes one way northbound to Pleasant Street. Tilton Avenue is a two way, two lane subcollector connecting Pleasant Street with Cherry Street. There is no stop sign at this intersection. However, it was observed that drivers generally behave as if Tilton Avenue was stop controlled. Therefore, the intersection was analyzed with stop control on Tilton Avenue.

Pleasant Street/Tilton Avenue Intersection

The intersection of Tilton Avenue with Pleasant Street is also a "T" intersection, located north-west of Ashland center and bordered by Residential-B and Industrial Districts. Pleasant Street is an east-west two lane, two way collector. Tilton Avenue is controlled by a stop sign at it's intersection with Pleasant Street.

Main Street/Pleasant Street Intersection

The intersection of Pleasant Street with Main Street is a "T" intersection located north of Ashland center and bordered by Residential-B, Industrial, and Commercial-B districts. Main Street is a north-south collector roadway. The eastbound Pleasant Street approach has an exclusive right turn lane and an exclusive left turn lane. The Pleasant Street approach is stop controlled.

Cherry Street/Summer Street Intersection

The intersection of Cherry Street with Summer Street is a "T" intersection located south of Ashland Center and just north of Route 135, in a mixed use district. Cherry Street is a two lane, two way subcollector. Traffic control is unusual in that there are two stop signs controlling two different legs at this intersection. Vehicles travelling south on Cherry Street are stopped before turning left or right onto Summer Street. Vehicles travelling west on Summer Street are stopped before the intersection with Cherry. Vehicles travelling east on Summer have a through movement. Analysis procedures were slightly modified to account for this configuration. The movements at this intersection were analyzed in two steps. The first assumed a stop sign to exist only for the Cherry Street southbound leg. This yielded a LOS rating for both movements on Cherry Street and the left turn from Summer onto Cherry. The second analysis assumed a stop sign on Summer Street only. This yielded a LOS rating for the southbound Summer Street movements.

Pleasant Street/High Street Intersection

The intersection of Pleasant Street with High Street is a "T" intersection located north-west of Ashland Center and west of the proposed station in an Industrial and Commercial-B district. Pleasant Street is a two lane, two way collector road. High Street is a two lane, two way subcollector road with stop control at Pleasant Street.

Results of the A.M. and P.M. peak hour analyses for the unsignalized intersections are listed in Table 1.8-2. The table shows the LOS rating as well as the reserve capacity, in vehicles, for each intersection movement. Unlike signalized intersections, only individual movements are assigned a level of service rating. The intersection cannot be assigned an overall rating. As shown in the table, most of the analyzed intersection movements operate at acceptable levels of service. During the A.M. roadway peak hour, the eastbound left turn movement from Pleasant Street onto Main Street operates at a LOS "F". During the P.M. roadway peak hour, the northbound left and right turn movements from Tilton Avenue to Pleasant Street and the eastbound left turn from Pleasant Street to Main Street operate at a LOS "E".

Table 1.8-2 1992 Existing Unsignalized Intersection Level of Service

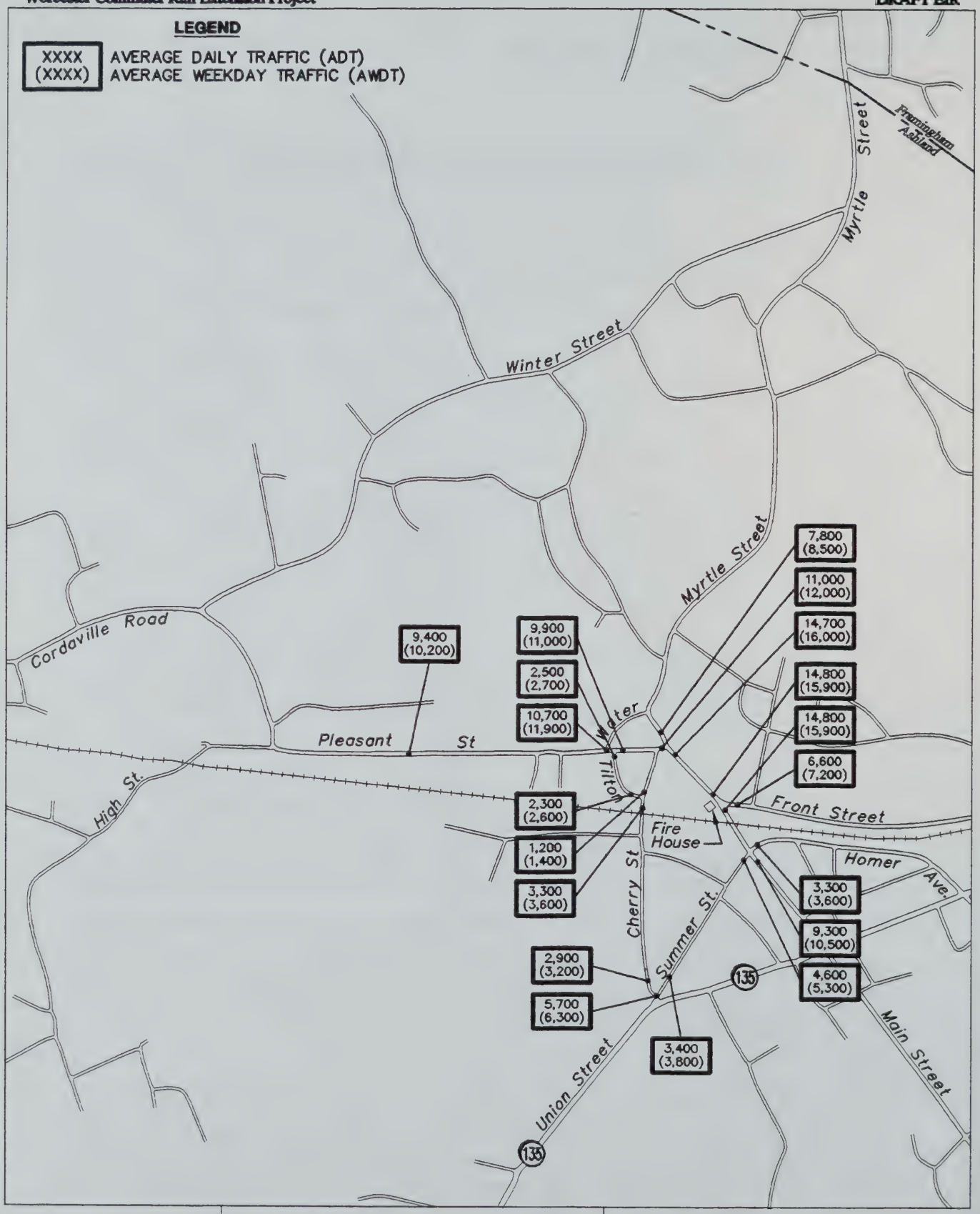
Ashland-East	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(639)	A(446)	A(630)	A(468)
LT and RT from High	B(346)	D(154)	B(336)	D(164)
Pleasant with Tilton				
LT from WB Pleasant	A(609)	A(517)	A(653)	A(589)
LT from Pleasant	D(102)	E(34)	D(137)	D(106)
Main with Pleasant				
LT from NB Main	A(505)	B(320)	A(518)	A(431)
LT from Pleasant	F(-72)	E(4)	F(-62)	E(64)
RT from Pleasant	A(440)	D(161)	A(474)	C(215)
Cherry with Tilton				
LT from NB Cherry	A(1122)	A(1072)	A(1122)	A(1098)
LT and RT from Tilton	A(951)	A(851)	A(956)	A(903)
Summer with Cherry				
LT from EB Summer	A(861)	A(792)	A(880)	A(864)
LT and RT from SB Cherry	A(717)	A(598)	A(702)	A(686)
THRU and RT from SB Summer	A(456)	B(352)	A(465)	A(444)

LOS (Reserve Capacity-Vehicles)

Results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.8-2. As shown in the Table, all of the unsignalized intersections operate at acceptable levels of service with the exception of the eastbound left turn movement from Pleasant Street onto Main Street which operates at a LOS "F" during the A.M. peak generator hour.

Roadway Segments

The average daily traffic (ADT) and average weekday traffic (AWDT) was collected for several streets in the downtown area of Ashland. Figure 1.8-5 presents the 1992 ADT and AWDT volumes for several streets showing the relative 24 hour volumes of traffic that use these streets. Several roadway segments were analyzed for level of service. These segments were analyzed using the procedures set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209,*



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

1992 Average Daily Traffic & 1992 Average Weekday Traffic ASHLAND, MA

FIGURE 1.8-5

(HCM). The software program "Highway Capacity Software" (HCS) was used to perform the analysis. The computerized outputs from HCS can be found in an uncirculated report available at the MBTA and MEPA. As with the intersection analysis, both the A.M. and P.M. roadway and site peak generator hours were analyzed. Table 1.8-3 lists the results of this analysis for the A.M. and P.M. peak roadway hours, and the A.M. and P.M. peak generator hours.

Table 1.8-3 1992 Existing Road Segment Level of Service

Ashland-East	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1174)	E(1183)	E(1229)	D(1366)
Pleasant Street East of Site	D(1307)	D(1319)	D(1360)	D(1500)
Cherry Street at Railroad Grade Crossing	C(1720)	C(1735)	C(1690)	C(1915)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table, of the roadway segments operate at acceptable levels of service. Even though Cordaville Road west of the proposed station location is shown to operate at a LOS "E", there is still sufficient reserve capacity to accommodate over 1,100 additional peak hour vehicles before reaching capacity.

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. Closing of the gates due to train crossings reduces the capacity of the roadway proportional to the length of time the traffic is stopped. As shown, the additional gate closings will not significantly impact level of service on Cherry Street.

Safety Concerns and Accident History

The Ashland Police Department was contacted on July 28, 1994, to determine the existence and location of any safety concerns or high accident history intersections. According to Lt. John Doveno, two locations are considered to be possible high frequency accident locations, both involving railroad grade crossings. These are the grade crossing at Main Street and the grade crossing at Cherry Street. Concern was also expressed about the possibility of increased traffic on the High Street and Fountain Street bridges due to additional drivers using these roads as alternate routes to avoid delays on Main Street in the center of town and the implications for emergency vehicles using these roads.

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

- Traffic volumes generated by planned developments within the study area.
- Increases in existing traffic volumes due to population growth and development proximate to, but outside of the study area.

Through discussions with the Town of Ashland, it was determined that no major new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of 1996 "No Build" condition traffic.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. The Massachusetts Highway Department compiles and publishes traffic volume data through a statewide traffic counting program. Five count sites from this data source are located within the immediate vicinity of the study area in Ashland. Based upon the data from these five sites, the traffic volume growth rate was found to be extremely low. Two of the locations experienced a growth rate of negative 2.5 percent. Two other locations experienced a growth rate of positive 2.5 percent and one location experienced a growth of 0.2 percent. A location along Route 9 east of 495 showed an average rate of negative 2.5 percent over the last 6 years.

This relatively low growth rate may be due to the economic downturn experienced throughout the region over the past years. Economic indicators point towards a recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

To account for this potential growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5 percent per year was applied to the 1992 existing condition traffic volumes. Figure 1.8-6 shows the projected A.M. peak hour traffic volumes. Figure 1.8-7 shows the projected P.M. peak hour traffic volumes. Figure 1.8-8 shows the A.M. peak generator hour traffic volumes. Figure 1.8-9 shows the P.M. peak generator hour traffic volumes.

The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to Worcester.

Year 1996 Trip Generation/Parking

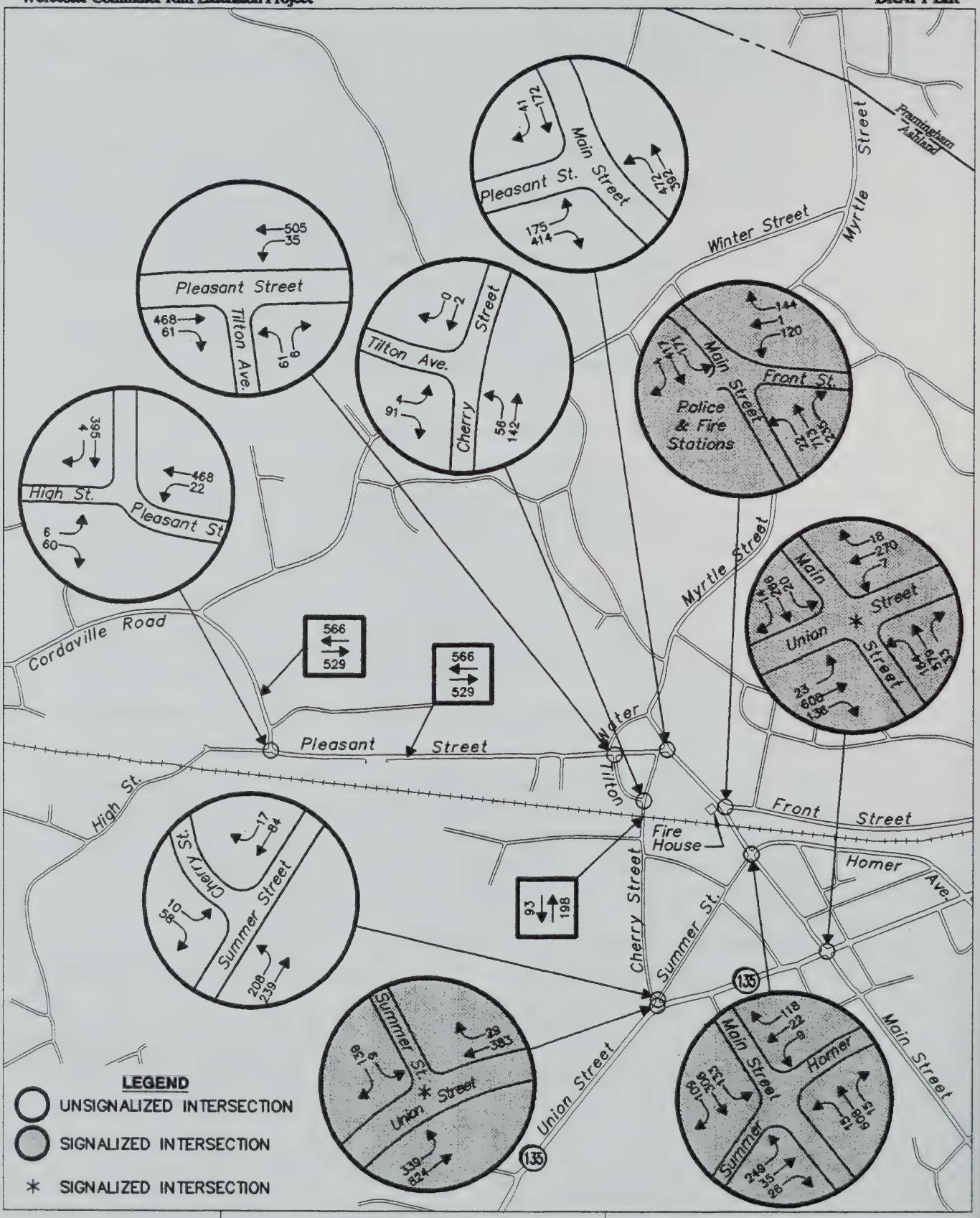
In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 persons are expected to utilize the railroad for daily round trip commutation into Boston.

In 1996, the proposed Ashland Station is projected to attract a total of 738 daily round trip commuters. Twenty of these patrons would walk to the station, while an additional 57 patrons would be dropped off. Based upon an average automobile occupancy rate of 1.12, the remaining 661 Park'n'Ride patrons would result in a parking demand of 590 spaces. This is less than the capacity of the proposed parking lot.

The patrons who will use the Ashland Station are projected to reside in the Towns of Ashland, Holliston, Hopkinton, Marlborough, and Southborough. Based on the proposed station location, all 20 of the patrons who walk to the station will reside in the Town of Ashland. The number of patrons who originate from each Town during the peak commuting periods are shown in Table 1.8-4.

Six percent of the total ridership is expected to occur outside of the peak A.M. and P.M. commuting periods, thus the 738 daily ridership was reduced to 693 riders during the peak commuting hours.

These ridership levels are expected to occur shortly after completion of the Ashland Station, therefore, these projections were used in the analysis of the 1996 "Build" conditions.



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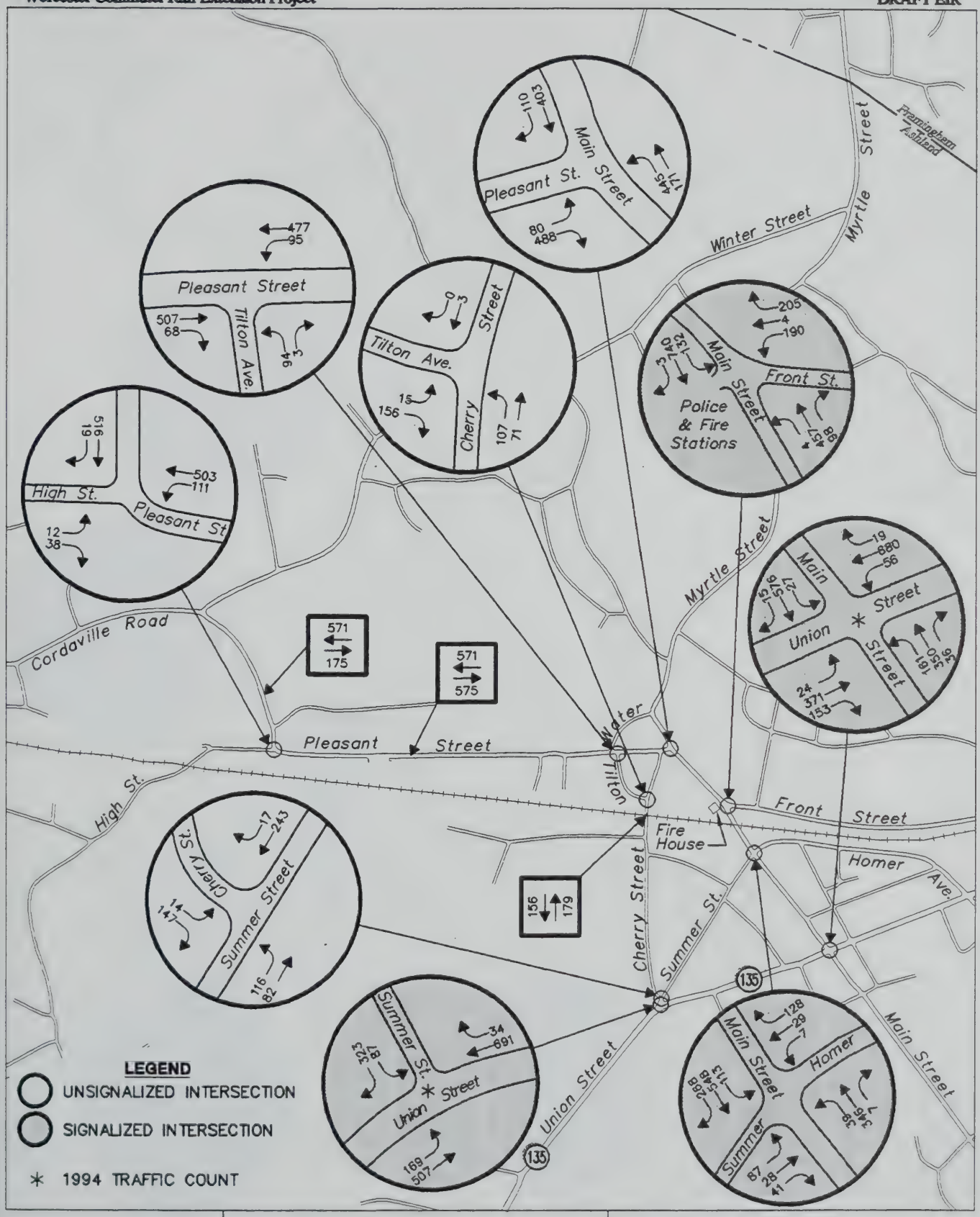
Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-6



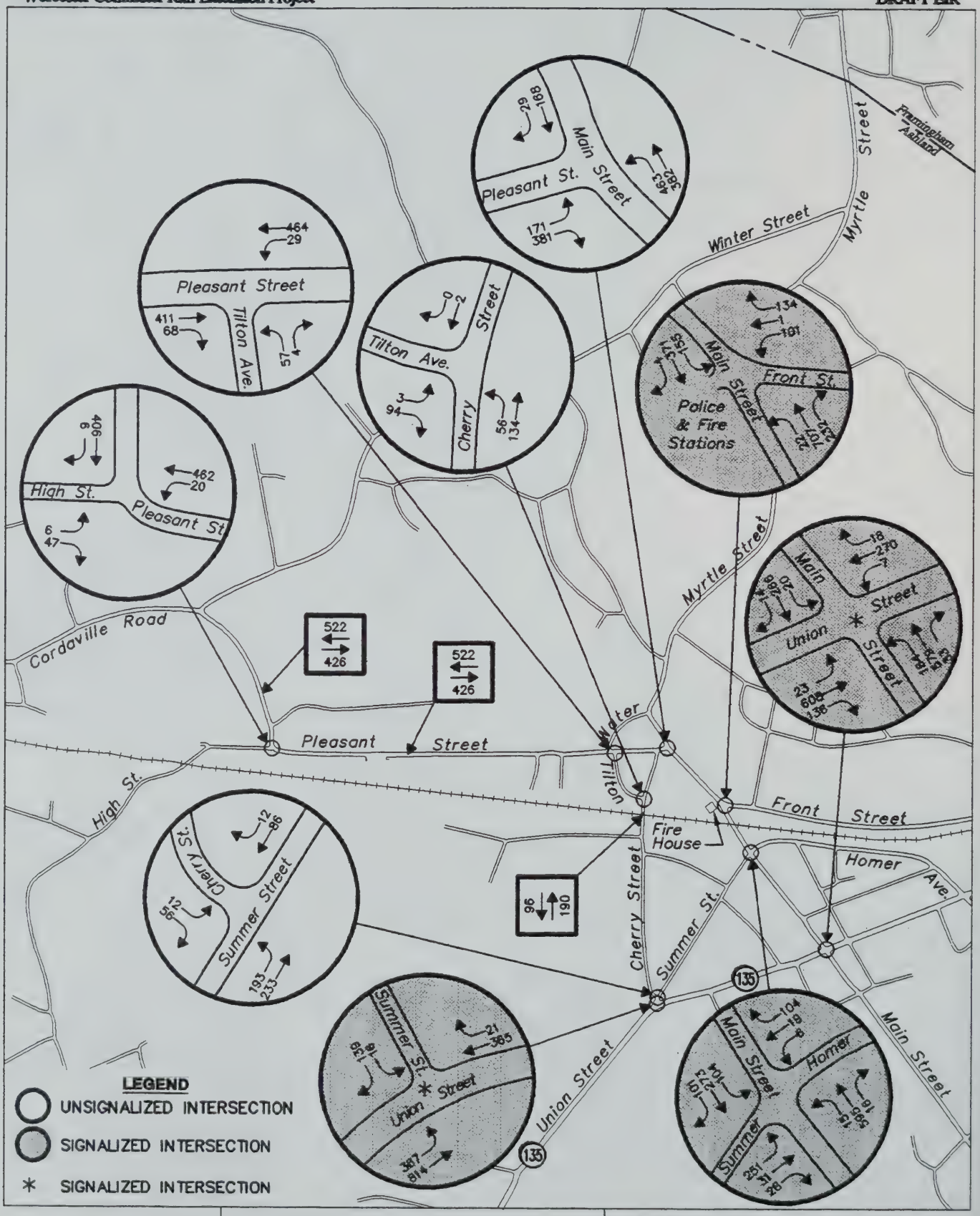
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-7



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

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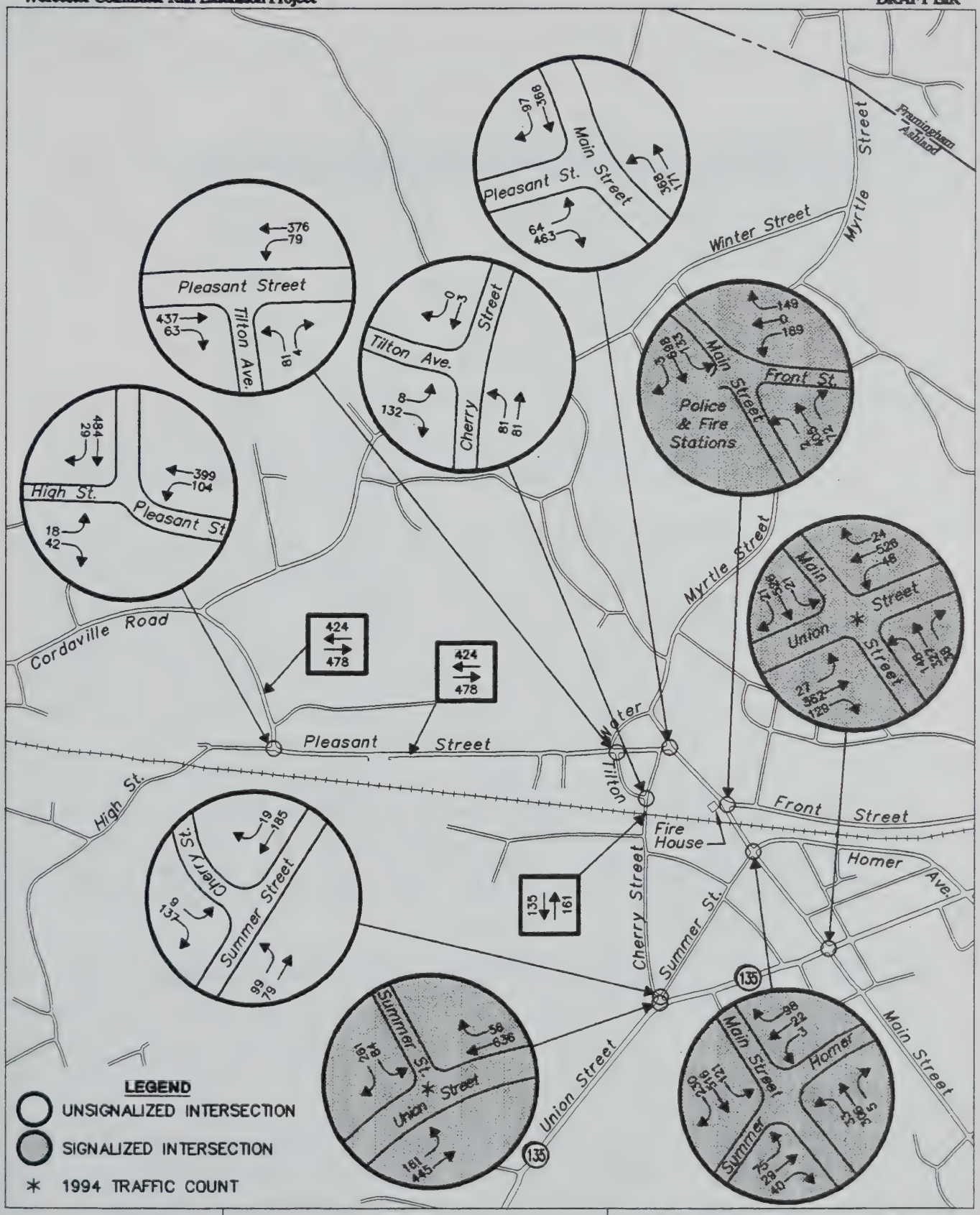
A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1996 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-8



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
7:30 - 8:30 A.M.
1996 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-9

Table 1.8-4 Projected Patrons of Ashland Station - Year 1996

Town	Riders*
Ashland	354**
Holliston	262
Hopkinton	44
Marlborough	10
Southborough	23
Total	**693**

* *Adjusted for peak period demand*
** *Includes 19 walk trips from Ashland*

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.8-5 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.8-5 MBTA Ridership Distribution

Inbound Train	Patrons
502A	136
504A	225
506A	225
510	107
Total	**693**
Outbound Train	**Patrons**
515A	97
519A	161
521	160
521A	240
523	35
Total	**693**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail stations peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Ashland Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 2 to 4 minutes on average.

In Ashland the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak generator hours for the commuter rail station will be from 7:15 to 8:15 A.M. and from 5:30 to 6:30 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Ashland would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station.

Patrons from Marlborough and Southborough would access the station's northern parking lot via Cordaville Road. Patrons from Holliston would access the station's southern parking lot via Main Street and Route 135. Patrons from Hopkinton will access the stations southern parking lot via Route 135. Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.8-10 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

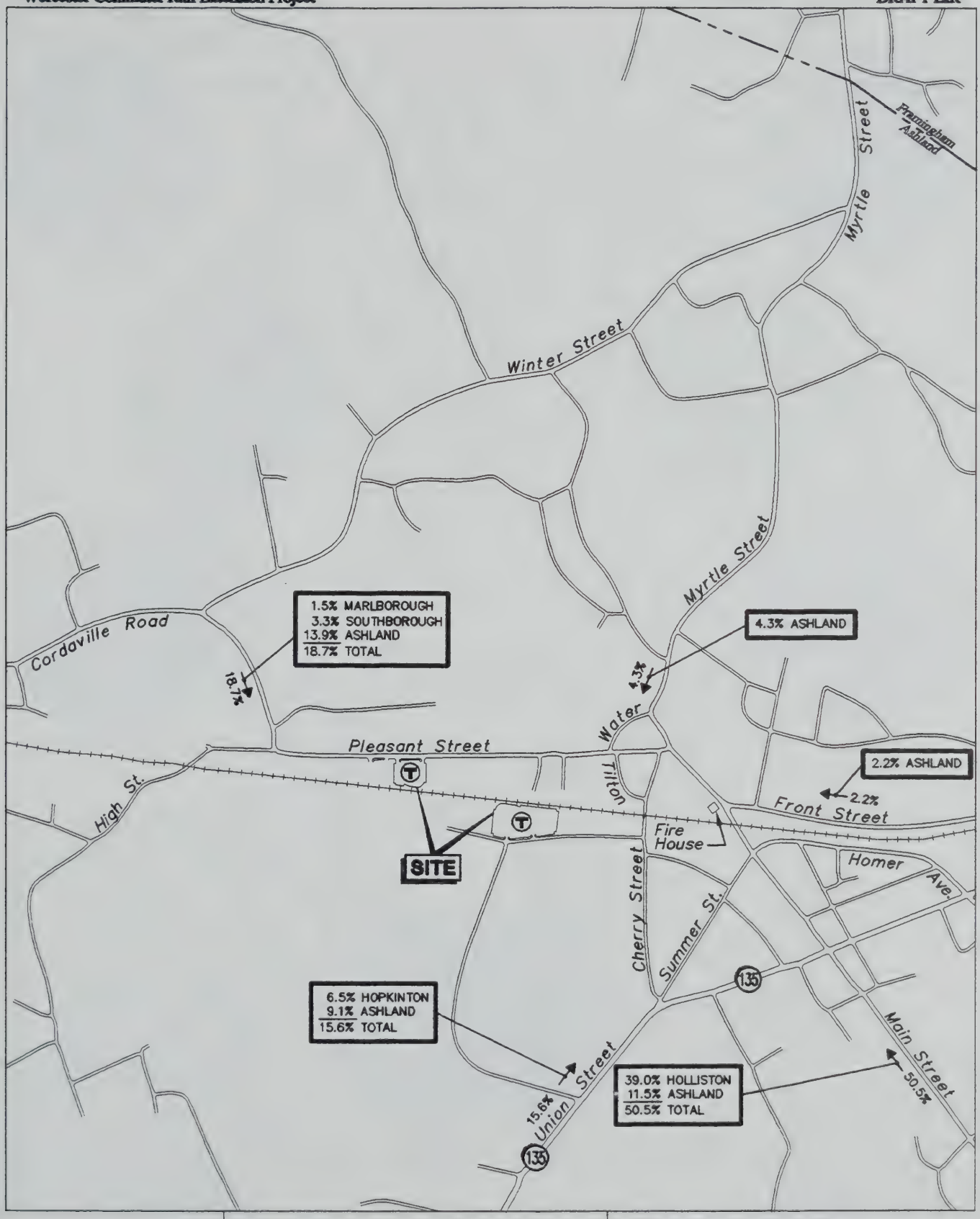
Upon completion of the commuter rail service, commuters will shift form automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the Study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along most portions of Routes 135 and 126, Route 9 and the Mass Pike. Traffic volumes are expected to increase on sections of Cordaville Road, Main Street, Pleasant Street, and Union Street near the commuter rail station.

Year 1996 "Build" Traffic Volumes

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Ashland rail station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Ashland Center, which includes Pleasant Street, Union Street, and Main Street. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways including Pleasant Street. This results in a "worst case" analysis. Figures 1.8-11 and 1.8-12 show the A.M. and P.M. peak hour traffic volumes respectively. Figures 1.8-13 and 1.8-14 show the A.M. and P.M. peak generator hour traffic volumes.



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Approx. Scale: 1" = 1250'±

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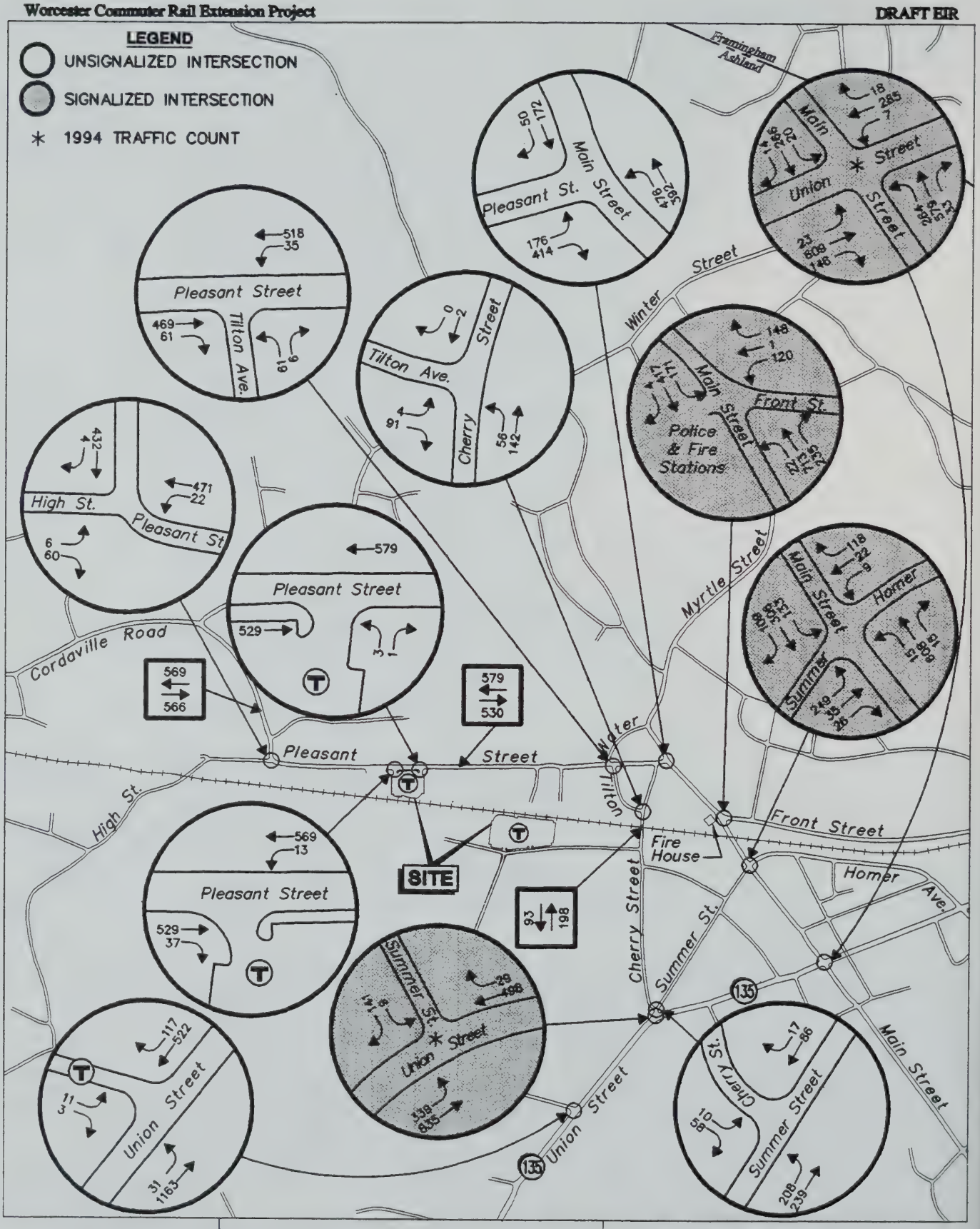
Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-10



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
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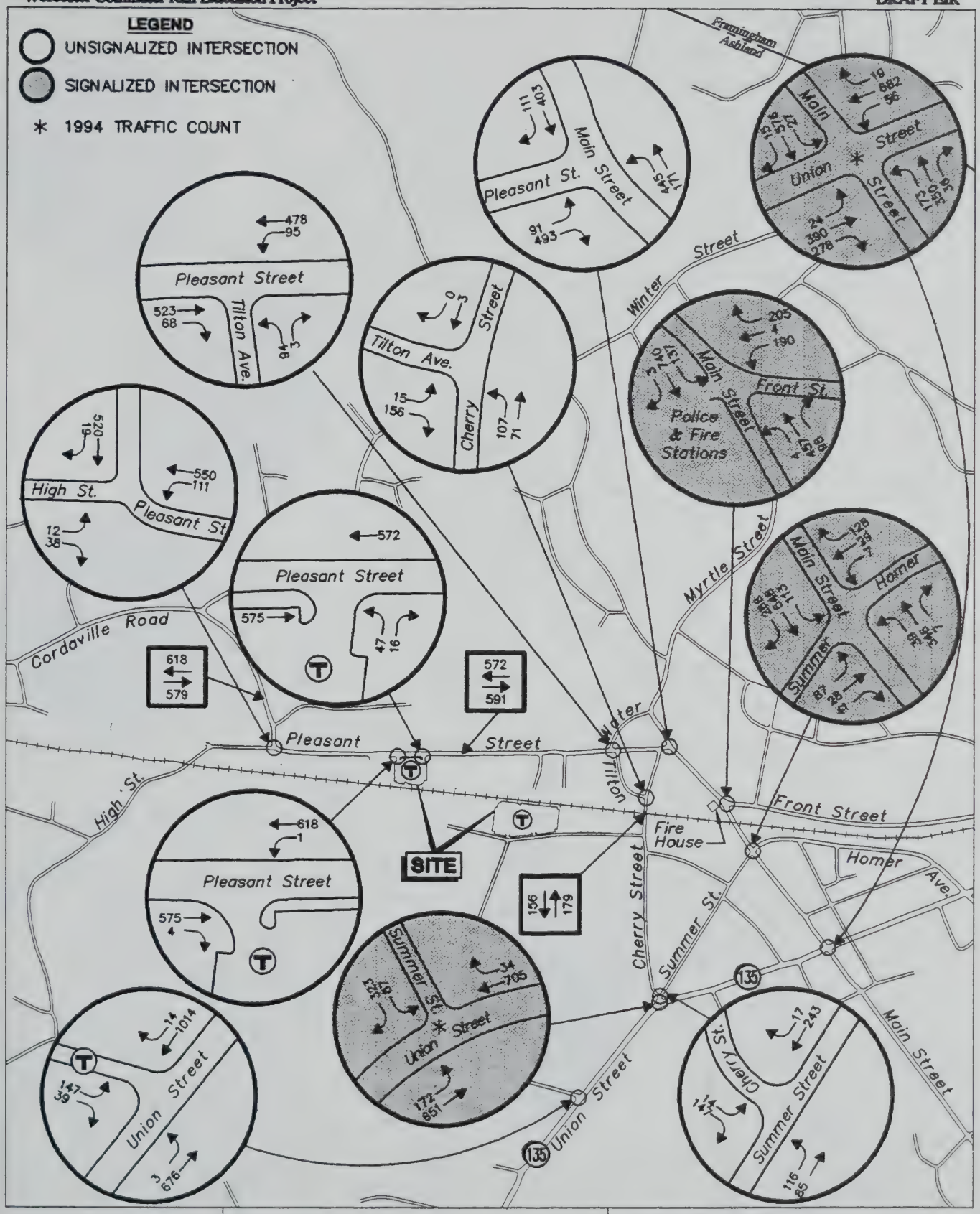
A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-11



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

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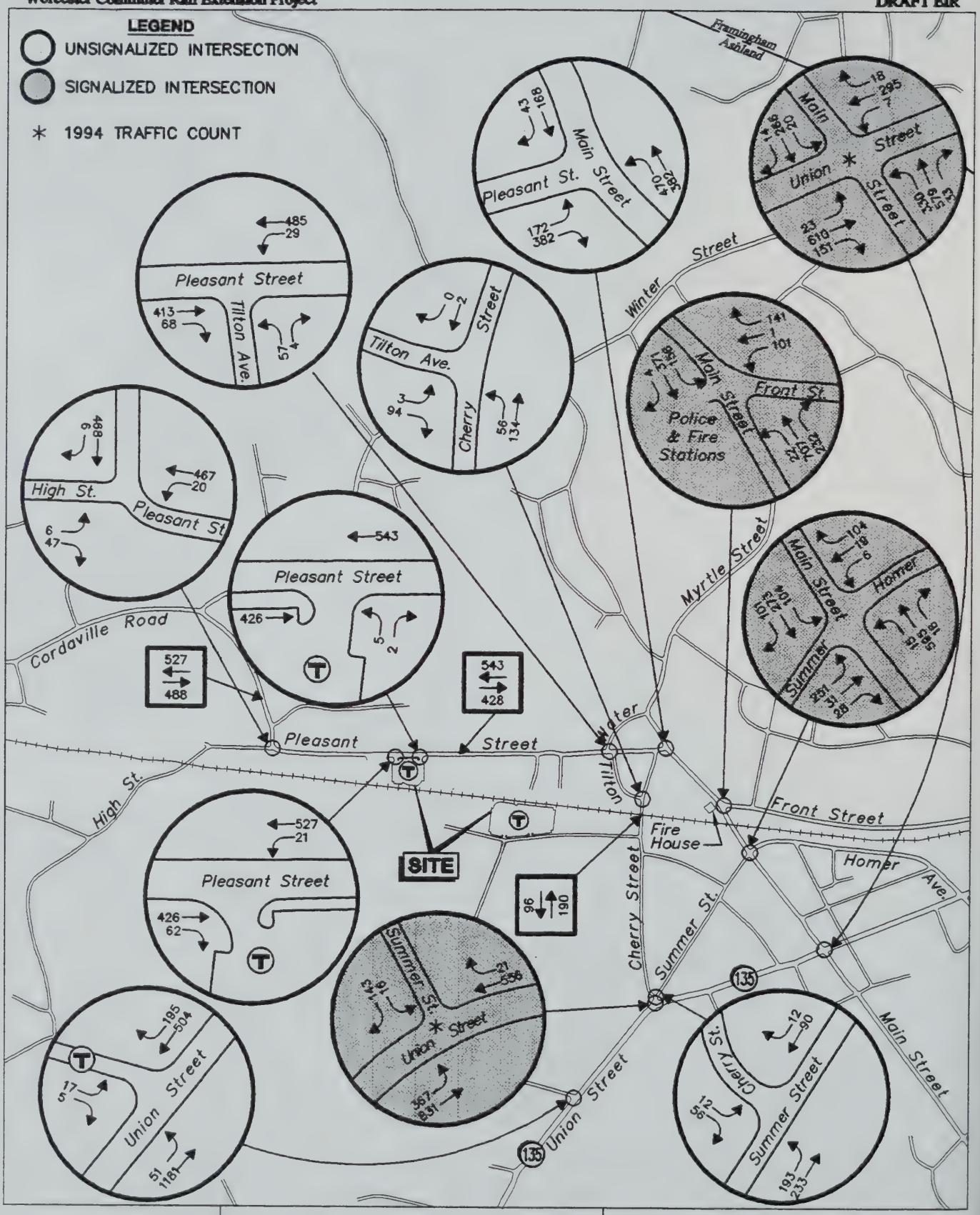
P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-12

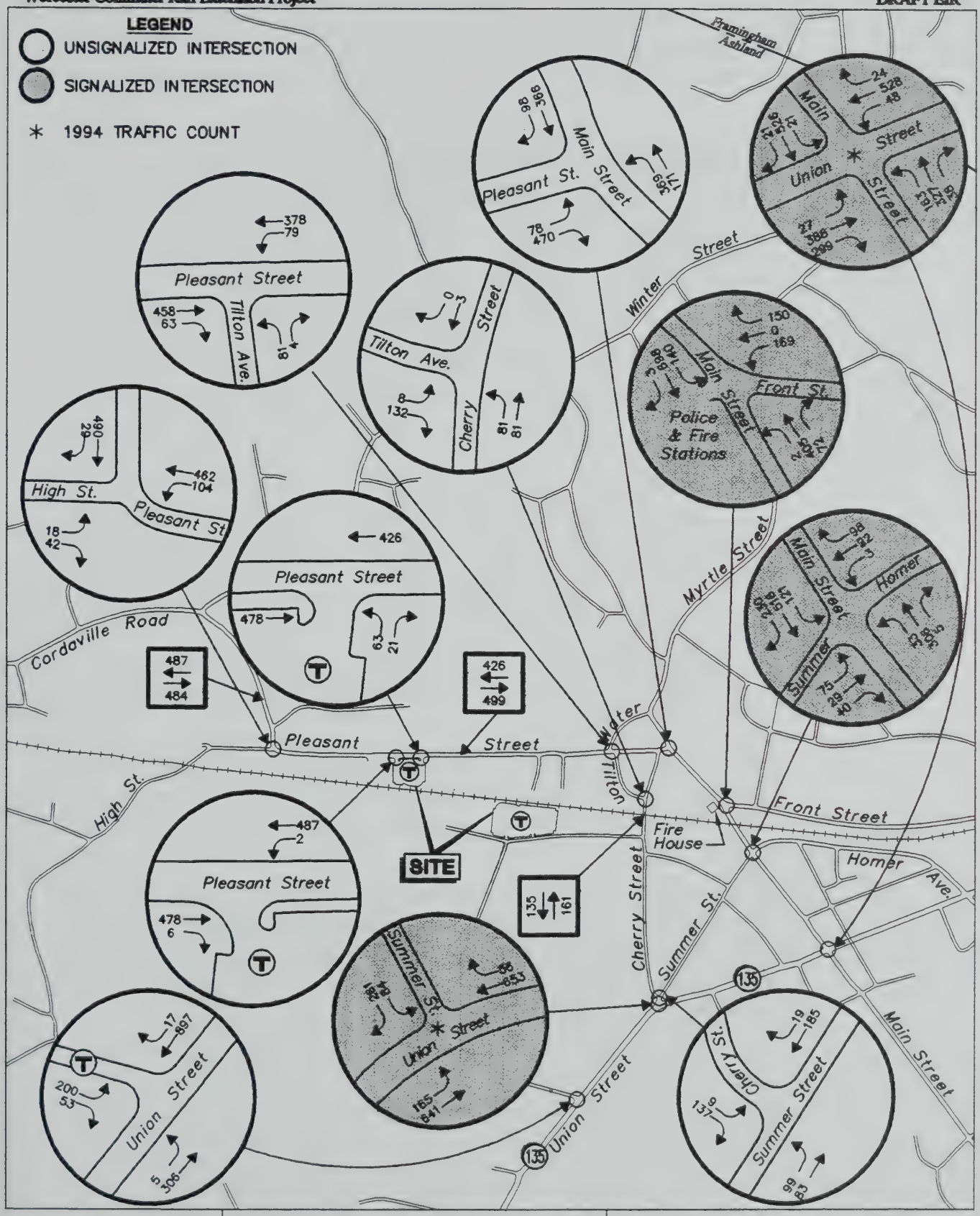


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-14

Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 1996 "No Build" condition were not changed from the existing conditions. For the 1996 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.8-6 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 1996 "No Build" and "Build" conditions. Under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at an overall acceptable level of service. During the A.M. peak hour, the northbound approach of Main Street would operate at a LOS "E". During the P.M. peak hour, the southbound approach of Main Street would operate at a LOS rating of "E".

Under the 1996 "Build" condition, the Main Street/Front Street intersection would operate at an overall acceptable level of service rating if the timings are optimized in both the A.M. and P.M. peak hours. The westbound approach will see a LOS rating of "E" in the P.M. peak hour.

Under the 1996 "No Build" condition, the Main Street/Summer Street intersection would operate at an acceptable LOS on all approaches during the P.M. peak hour. During the A.M. peak hour, the intersection would operate at an overall LOS rating of "E" with the eastbound approach of Summer Street and the southbound approach of Main Street operating at a LOS rating of "F".

Table 1.8-6 1996 Peak Hour Signalized Intersection Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(32.2)	D(33.6)	B(10.9)	C(20.9)
Westbound	C(23.2)	D(25.3)	D(33.5)	E(59.9)
Northbound	E(48.7)	C(15.7)	B(10.0)	A(4.5)
Southbound	B(9.4)	E(47.1)	A(2.3)	C(15.8)
Main with Summer	E(42.3)	B(13.8)	E(56.2)	B(7.5)
Eastbound	F(68.8)	C(18.9)	F(139)	C(24.2)
Westbound	C(17.1)	C(17.0)	C(21.6)	C(15.8)
Northbound	B(13.3)	B(7.9)	B(14.9)	A(2.9)
Southbound	F(68.1)	B(14.9)	F(68.3)	B(5.2)
Main with Union	F*	D(28.4)	D(32.1)	E(41.6)
Eastbound	F*	C(17.8)	D(36.8)	E(54.3)
Westbound	B(8.0)	E(58.2)	B(8.8)	E(40.8)
Northbound	C(15.8)	B(12.6)	E(43.1)	E(46.9)
Southbound	B(7.2)	C(16.0)	B(13.9)	C(23.7)
Union with Summer	F*	F*	D(25.2)	F(92.9)
Eastbound	F*	B(13.6)	C(18.0)	E(47.6)
Westbound	F(66.8)	F*	D(29.4)	F(114)
Southbound	B(14.2)	F(64.9)	F(64.7)	F(150)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the 1996 "Build" condition, the Main Street/Summer Street intersection would operate at LOS "F" during the A.M. peak hour even with the optimization of the traffic signal timing. The eastbound Summer Street approach and the northbound Main Street approach will have a LOS rating of "F". During the P.M. peak hour with the retiming of the traffic signal the overall LOS rating can be improved to a very acceptable LOS rating of "B" with no approaches seeing a poor LOS rating.

Under the 1996 "No Build" conditions, the Main Street/Union Street intersection will be operating at an overall unacceptable LOS rating of "F*", this is due to the eastbound Union Street approach having the unacceptable LOS rating of "F*". The other approaches will have acceptable LOS ratings during the A.M. peak hour.

During the P.M. peak hour the overall LOS rating will be acceptable, but the westbound Union Street will have a LOS rating of "E".

Under the "Build" condition, the Main Street/Union Street intersection will operate satisfactorily in both the A.M. and P.M. peak hours. In the P.M. peak hour the intersection will function at LOS "E". The northbound approach will operate at LOS "E" in the A.M. and P.M. peak hours, while the eastbound and westbound approaches will be at LOS "E" in the P.M. peak hour.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.8-7. Under the 1996 "No Build" conditions, most of the intersection movements would operate at an acceptable level of service. The northbound left and right turn movements from Tilton Avenue to Pleasant Street would operate at a LOS "E" during both the A.M. and P.M. peak hours. The eastbound left turn movement from Pleasant Street onto Main Street would operate at an unacceptable LOS "F" during both the A.M. and P.M. peak hours.

Table 1.8-7 1996 Peak Hour Unsignalized Intersection Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(635)	A(442)	A(605)	A(439)
LT and RT from High	B(342)	D(150)	B(317)	D(137)
Pleasant with Site's West DW				
LT from WB Pleasant	-	-	A(596)	A(599)
Pleasant with Site East DW				
LT from Parking Lot	-	-	D(134)	E(81)
RT from Parking Lot	-	-	A(515)	A(469)
Pleasant with Tilton				
LT from WB Pleasant	A(601)	A(507)	A(600)	A(495)
LT and RT from Tilton	E(95)	E(26)	E(91)	E(22)
Main with Pleasant				
LT from NB Main	A(493)	B(304)	A(489)	B(304)
LT from Pleasant	F(-81)	F(-4)	F(-84)	F(-15)
RT from Pleasant	A(429)	D(144)	A(429)	D(139)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1070)	A(1121)	A(1070)
LT and RT from Tilton	A(949)	A(848)	A(949)	A(848)
Summer with Cherry				
LT from EB Summer	A(855)	A(785)	A(853)	A(785)
LT and RT from SB Cherry	A(712)	A(590)	A(710)	A(590)
THRU and RT from WB Summer	A(447)	B(341)	A(445)	B(340)
Union with Site's South DW				
LT from EB Union	-	-	A(527)	B(338)
LT from Parking Lot	-	-	E(24)	F(-105)
RT from Parking Lot	-	-	A(478)	C(216)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, most of the analyzed intersection movements would operate at acceptable levels of service. The northbound left and right turns from Tilton Street to Pleasant Street would continue to operate at a LOS rating of "E" during the A.M. and P.M. peak hours. The eastbound left turn from Pleasant Street to Main Street would remain at unacceptable LOS "F" during both the A.M. and P.M. peak hours.

In addition to the intersections analyzed under the 1992 Existing and 1996 "No Build" scenarios, the intersections of the proposed station access driveways with Pleasant Street and Union Street were analyzed under the 1996 "Build" conditions. As shown, generally the movements at these intersections would operate at an acceptable level of service during both the A.M. and P.M. peak hours. The southbound left turns from the south driveway to eastbound Union Street will have an A.M./P.M. peak hour LOS ratings of "E"/"F". The P.M. peak hour northbound left turning traffic from the east driveway to westbound Pleasant Street will see a LOS rating of "E".

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.8-8 lists the results of this analysis for the A.M. and P.M. peak hours.

Table 1.8-8 1996 Peak Hour Road Segment Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1151)	E(1160)	E(1162)	E(1091)
Pleasant Street East of Site	D(1284)	D(1296)	D(1294)	D(1276)
Cherry Street at Railroad Crossing	C(1713)	C(1802)	C(1579)	D(1638)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

As shown in the table in the "No Build" condition, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,100 additional vehicles before reaching capacity.

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. Closing of the gates due to train crossings reduces the capacity of the roadway proportional to the length of time the traffic is stopped. As

seen in the table, the stopping of traffic for train crossings does not have a significant impact on the flow of traffic along Cherry Street.

Under the 1996 "Build" condition, only Cordaville Road west of the site segment in the A.M. and P.M. roadway peak hours would operate at an level of service rating of "E". Although this roadway segment is listed as LOS "E", the segment can accommodate an additional 1050 vehicles or more before reaching capacity.

Year 1996 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generator hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.8-9 for the 1996 "No Build" and "Build" conditions.

As shown in the table, under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at a LOS "D" during the A.M. and P.M. peak generator hours. The northbound approach of Main Street would operate at a LOS "E". The Main Street/Summer Street intersection would operate at acceptable levels of service on all approaches during the P.M. peak generator hour. During the A.M. peak generator hour, the intersection would operate at an overall LOS "D", with the eastbound Summer Street approach operating at a LOS rating of "F".

In the P.M. peak generator hour all the approaches of the Main Street/Union Street intersection will be operating at acceptable LOS ratings. In the A.M. peak generator hour the overall LOS rating for this intersection will be F*. This is due to the eastbound Union Street's LOS rating being F*. The intersection of Union Street with Summer Street will see both the A.M. and P.M. overall peak generator hour LOS ratings of "F*". In the A.M. peak generator hour it is the eastbound Union Street approach which has the "F*" rating and in the P.M. peak generator hour it is the eastbound Union Street traffic which has the "F*" LOS rating. In addition to the approaches having a LOS rating of "F*", westbound Union Street has a LOS rating of "F" in the A.M. peak generator hour and southbound Summer Street will have a LOS rating of "E" in the P.M. peak generator hour.

Under the "Build" condition, during the A.M. peak generator hour, the Main Street/Front Street intersection would operate at an overall acceptable LOS rating in both the A.M. and P.M. peak generator hours. The westbound Front Street approach will see a LOS rating of "E" in the P.M. peak generator hour. The Main Street/Summer Street intersection will be operating at acceptable LOS ratings in both peak generator hours. In the A.M. peak generator hour the overall LOS rating will be "E", due to the eastbound Summer Street approach being LOS rating "F" and the

southbound Main Street approach LOS rating being an "E". The intersection of Main Street/Union Street will see an overall LOS rating of "E" in both the A.M. and P.M. peak generator hours. This is due to the northbound Main Street approach's A.M. and P.M. peak generator LOS rating being "E" and the eastbound Union Street approach's LOS rating being "E" and "F" in the A.M. and P.M. peak generator hours. At the intersection of Union Street/Summer Street, the overall LOS rating will be an acceptable "D" in the A.M. peak generator hour and an unacceptable "F" in the P.M. peak generator hour. The westbound Union Street approach will have a LOS rating of "E" in the A.M. peak generator hour, while the southbound Summer Street approach will have a LOS rating of "F". During the P.M. peak generator hour all of the approaches will see a LOS rating of "E" or "F".

As with the 1992 Existing condition analysis, approach capacities used for analysis of the intersections of Main Street with Front Street and Main Street with Summer Street were adjusted to account for the additional railroad gate closings. The signal timings were optimized to account for the changes in traffic volumes.

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.8-10. Under the 1996 "No Build" conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during the P.M. hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" and a LOS "E" during the A.M. and P.M. peak generator hours respectively.

Table 1.8-9 1996 Peak Generator Hour Signalized Intersection Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(33.2)	D(28.9)	B(9.3)	C(17.5)
Westbound	C(22.8)	D(25.5)	D(29.8)	E(47.6)
Northbound	E(49.6)	B(14.3)	B(8.1)	A(4.5)
Southbound	B(8.3)	D(38.1)	A(2.1)	B(13.0)
Main with Summer	D(35.2)	C(17.7)	E(47.4)	B(7.5)
Eastbound	F(86.3)	C(18.5)	F(117)	D(25.5)
Westbound	C(16.6)	C(16.7)	C(16.7)	C(15.7)
Northbound	B(13.5)	B(7.7)	C(16.5)	A(2.5)
Southbound	D(35.9)	C(21.4)	E(51.6)	B(5.5)
Main with Union	F*	C(19.5)	E(40.1)	E(43.7)
Eastbound	F*	C(16.7)	E(55.6)	F(71.6)
Westbound	B(8.0)	D(32.9)	B(11.7)	D(25.4)
Northbound	C(15.8)	B(10.2)	E(45.7)	E(48.2)
Southbound	B(7.2)	B(14.6)	B(14.8)	D(25.1)
Union with Summer	F*	F*	D(37.7)	F(81.0)
Eastbound	F*	B(13.0)	D(25.9)	E(42.3)
Westbound	F(63.9)	F*	E(45.7)	F(98.0)
Southbound	B(14.2)	E(42.5)	F(95.6)	F(135)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Table 1.8-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(627)	A(464)	A(578)	A(459)
LT and RT from High	B(333)	D(160)	C(293)	D(140)
Pleasant with Site's West DW				
LT from WB Pleasant	-	-	A(647)	A(669)
Pleasant with Site East DW				
LT from Parking Lot	-	-	D(172)	D(136)
RT from Parking Lot	-	-	A(590)	A(532)
Pleasant with Tilton				
LT from WB Pleasant	A(645)	A(579)	A(644)	A(563)
LT and RT from Tilton	D(129)	E(97)	D(122)	E(89)
Main with Pleasant				
LT from NB Main	A(506)	A(417)	A(499)	A(416)
LT from Pleasant	F(-71)	E(57)	F(-76)	E(42)
RT from Pleasant	A(463)	C(200)	A(462)	D(139)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1069)	A(1121)	A(1096)
LT and RT from Tilton	A(954)	A(900)	A(954)	A(900)
Summer with Cherry				
LT from EB Summer	A(874)	A(858)	A(869)	A(858)
LT and RT from SB Cherry	A(696)	A(679)	A(692)	A(678)
THRU and RT from WB Summer	A(457)	A(434)	A(452)	A(432)
Union with Site's South DW				
LT from EB Union	-	-	A(467)	B(391)
LT from Parking Lot	-	-	E(13)	F(-88)
RT from Parking Lot	-	-	A(463)	C(250)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, the analyzed intersection movements would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during the P.M. peak generator hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" during the A.M. peak generator hour, and at a LOS "E" during the P.M. peak generator hour.

The additional intersections along Pleasant Street and Union Street at the proposed site driveways were also analyzed. The intersections at the proposed driveways would generally operate acceptably during both the A.M. and P.M. peak generator hours. Left turning traffic from the south driveway heading east on Union Street will have an A.M./P.M. LOS rating of "E" and "F", respectively.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.8-11 lists the results of this analysis for the A.M. and P.M. peak generator hours.

Table 1.8-11 1996 Peak Generator Hour Road Segment Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1221)	D(1347)	E(1250)	E(1348)
Pleasant Street East of Site	D(1339)	D(1481)	E(1370)	D(1472)
Cherry Street at Railroad Grade Crossing	C(1684)	C(1834)	D(1511)	C(1712)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table, for the "No Build" condition, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,200 additional vehicles before reaching capacity.

Under the "Build" condition, all roadway segments during the A.M. and P.M. peak generator hours would operate at an acceptable level of service. Although the roadway segment of Cordaville Road west of the site is listed as LOS "E", this road segment can accommodate an additional 1,250 vehicles or more before reaching capacity.

The roadway segment analysis performed for Cherry Street at the railroad crossing demonstrates that additional gate closings during peak generator hours do not significantly impact the flow of traffic along Cherry Street.

Year 1996 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.8-12 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in Table 1.8-12, no intersection would receive 10 percent or more of its 1996 "Build" traffic from the proposed rail station during roadway peak hours.

As shown in Table 1.8-12, no roadway segments would receive 10 percent on more of their 1996 "Build" traffic volume from the proposed commuter rail station during the A.M. and P.M. peak hours.

Table 1.8-12 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Pleasant with High	4.2%	4.3%
Pleasant and Site's West Driveway	4.8%	4.5%
Pleasant and Site East Driveway	5.0%	5.6%
Pleasant and Tilton	1.2%	1.4%
Main and Pleasant	0.8%	1.0%
Main and Front	0.2%	0.3%
Main and Summer	0.0%	0.0%
Main and Union	6.1%	6.4%
Cherry with Tilton	0.0%	0.0%
Summer with Cherry	0.3%	0.5%
Union with Summer	7.4%	8.9%
Union with Site's South Driveway	9.6%	9.5%
Roadway Segment		
Cordaville Rd. West of Site	3.7%	4.5%
Pleasant St. East of Site	1.3%	1.5%
Cherry St. at Railroad Crossing	0.0%	0.9%

Site generated traffic as a percentage of total traffic

Year 1996 Ashland Station Only

To determine the impacts to the study area for the Ashland Station, if for some reason the other suburban stations are delayed in coming into service an "Ashland Station Only" analysis was performed. This analysis assumes that Ashland is the only station built by 1996 (in addition to a Worcester Station). As done for the year 1996 analysis the conditions will be a base "No Build" to be compared against a "Build" condition to determine the impacts of the commuter rail station. The standard assumptions were made that no significant changes, additions, or deletions will be made to the roadway network.

The 1996 "No Build" volumes, for both peak hours and peak generator hours were previously presented and serve as the same base for the "Ashland Station Only" analysis as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Ashland Station Only)

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension should the service to Worcester include stopping only in Ashland in between Worcester and Framingham stations. The CTPS projected that by the year 2011, a total of 2,701 persons are expected to utilize the railroad for daily round trip commuting into Boston, if adequate parking can be developed.

In the year 1996, the proposed Ashland Station is projected to attract a total of 1,041 daily round trip commuters. Twenty of these patrons would walk to the station, while an additional 82 patrons would be dropped off. Based upon an average automobile occupancy rate of 1.12, the remaining 939 Park'n'Ride patrons would result in a parking demand of 840 parking spaces.

The patrons who will use the Ashland Station are projected to reside in the Towns of Ashland, Holliston, Hopkinton, Marlborough, Southborough, and Westborough. Based on the proposed station location, all 20 of the patrons who walk to the station will reside in the Town of Ashland. The number of patrons who originate from each Town during the peak commuting periods shown in Table 1.8-13.

Six percent of the total ridership is expected to occur outside of the peak A.M. and P.M. commuting periods, thus the 1,041 daily ridership was reduced to 978 riders during the peak commuting hours.

Table 1.8-13 Projected Patrons of Ashland Station - Year 1996 (Ashland Station Only)

Town	Riders*
Ashland	354**
Holliston	262
Hopkinton	92
Marlborough	171
Southborough	76
Westborough	23
Total	**978**

* *Adjusted for peak period demand*
** *Includes 19 walk trips from Ashland*

Year 1996 Trip Distribution and Assignment (Ashland Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will very depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.8-14 lists projected distribution of ridership based on arrival/departure time in Boston.

Table 1.8-14 MBTA Ridership Distribution (Ashland Station Only)	
Inbound Train	**Patrons**
502A	192
504A	317
506A	317
510	152
Total	**978**
Outbound Train	**Patrons**
515A	137
519A	227
521A	226
523A	339
523	49
Total	**978**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M. Thus, there because a need to analyze two peak hours; the roadway peak hour and the commuter rail stations peak generator hour.

The peak generator hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Ashland Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 2 to 4 minutes on average.

In Ashland the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak generator hours for the commuter rail station will be from 7:15 to 8:15 A.M. and from 5:30 to 6:30 P.M.

Once the projected generated vehicle trips were distributed overtime, the resulting peak hour totals were assigned to the study are roadway system. Patrons who reside

in Ashland would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station.

Patrons from Marlborough, Southborough, and Westborough would access the station's northern parking lot via Cordaville Road. Patrons from Holliston would access the station's southern parking lot via Main Street and Route 135. Patrons from Hopkinton will access the southern parking lot via Route 135. Actual routing was estimated based on the shortest travel time and distance from population centers. Figure 1.8-15 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

Upon completion of the commuter rail service, commuters will shift form automobile only usage to automobile/rail usage to travel to Boston. Work vehicle trips will be of a shorter duration. Traffic volumes are expected to decrease along most portions of Route 135 and 126, Route 9, and the Mass Pike. Traffic volumes are expected to increase on the sections of Cordaville Road, Main Street, Pleasant Street, and Union Street near the commuter rail station.

Year 1996 "Build" Traffic Volumes (Ashland Station Only)

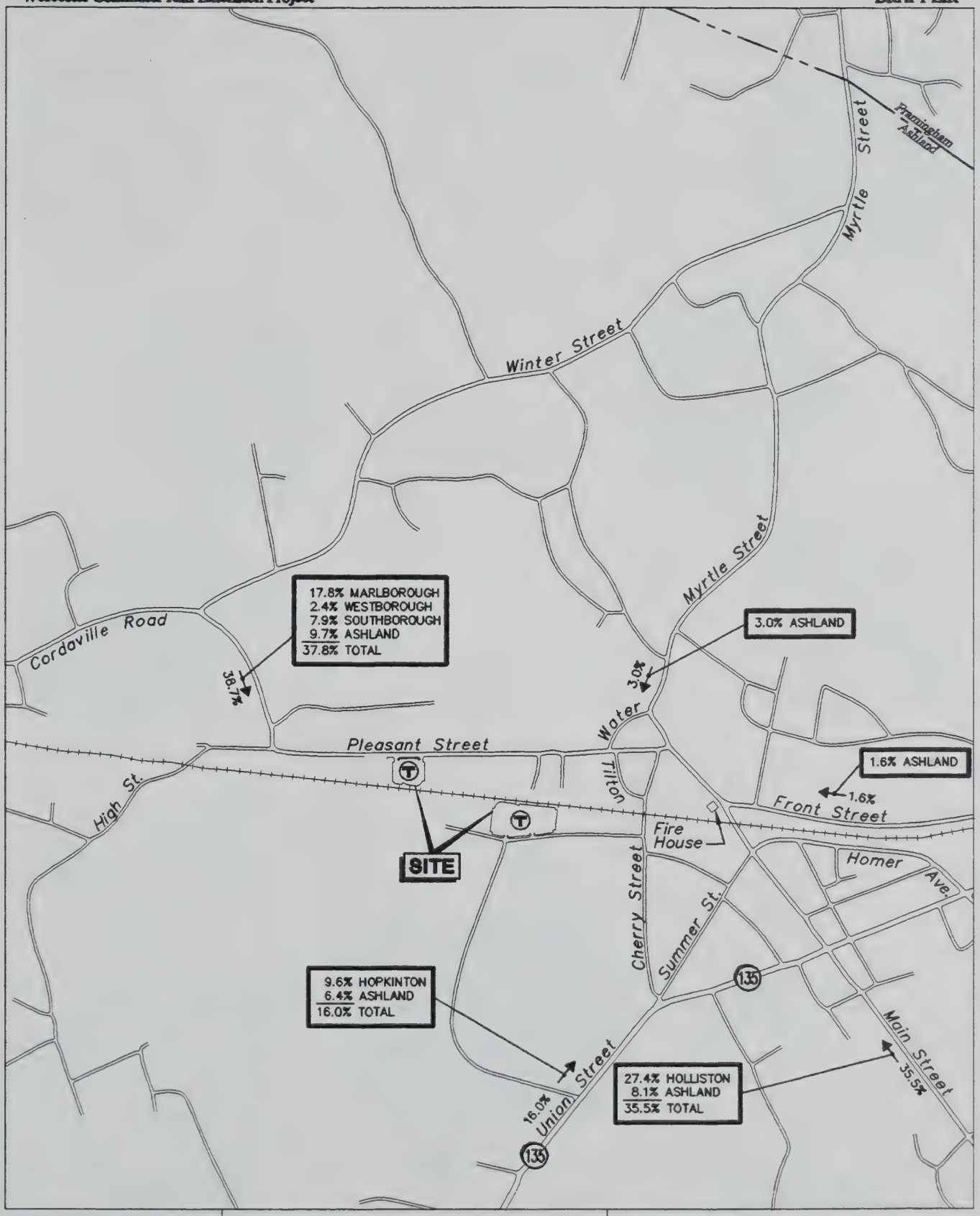
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected 1996 "No Build" traffic volumes
- Traffic specifically diverted to the proposed Ashland Rail Station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Ashland Center, which includes Pleasant Street, Union Street, and Main Street. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reductions in volume on specific roadways including Pleasant Street. This results in a "worst case" analysis. Figures 1.8-16 and 1.8-17 show the A.M. and P.M. peak hour traffic volumes. Figures 1.8-18 and 1.8-19 show the A.M. and P.M. peak generator hour traffic volumes.

Year 1996 Peak Hour Levels of Service (Ashland Station Only)

The same study area elements that were analyzed under the 1992 existing conditions were analysis under the 1996 "No Build" and "Build" Ashland Station Only conditions. The analysis was performed using the "all else being equal" assumption



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

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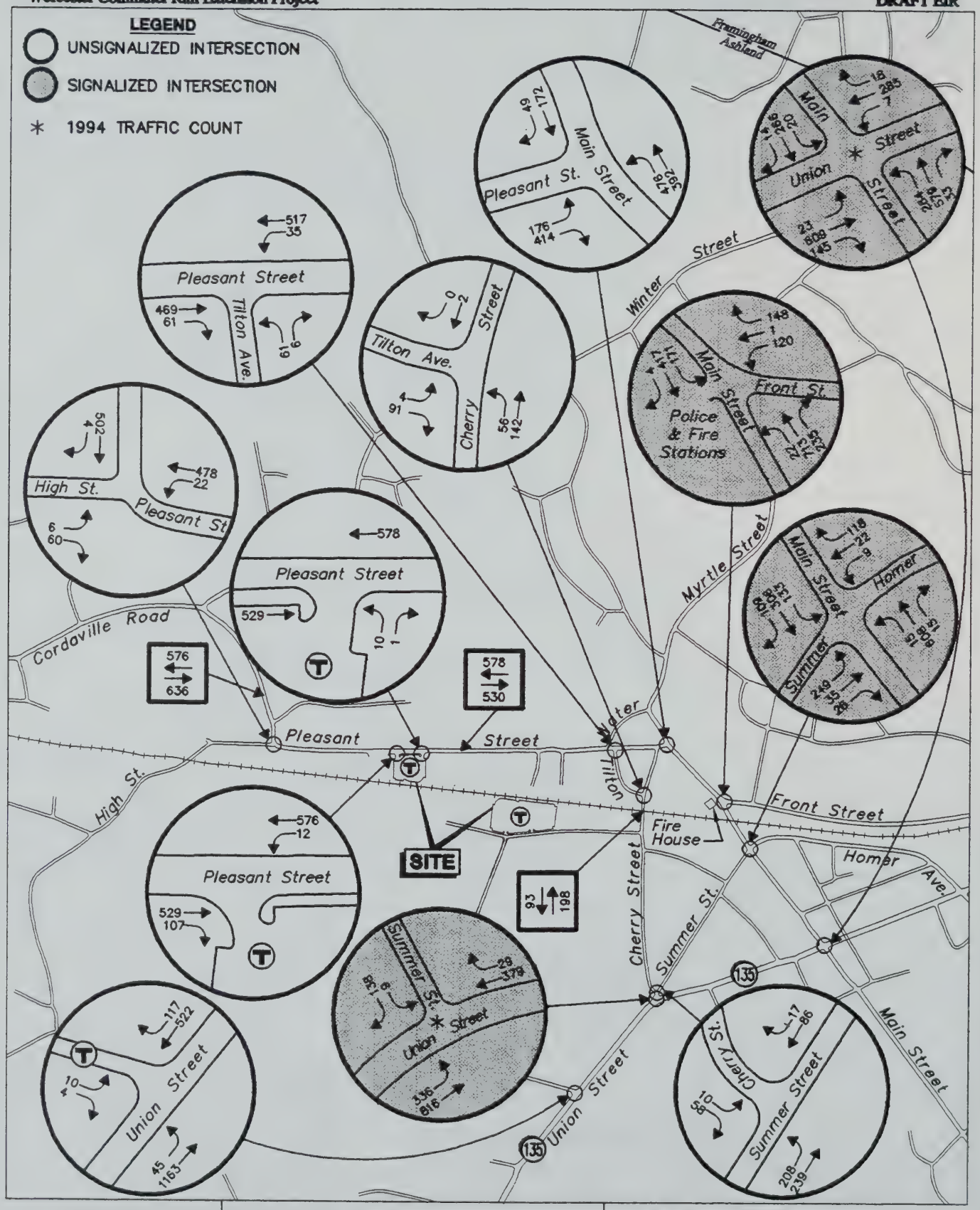
Distribution of Commuter Rail Station Traffic 1996 BUILD Ashland Only ASHLAND STATION-EAST

FIGURE 1.8-15



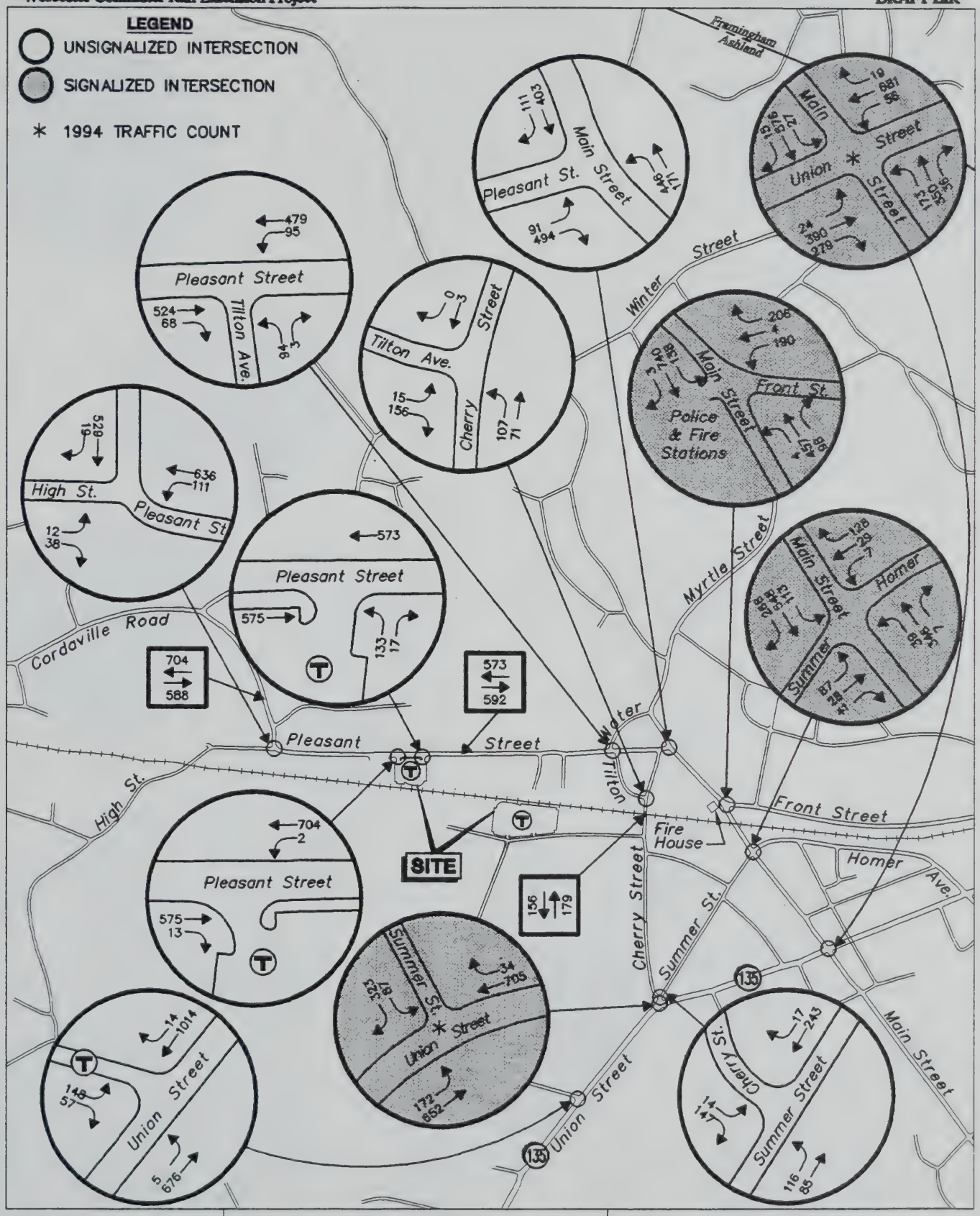
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD Ashland Only
ASHLAND STATION-EAST

FIGURE 1.8-16

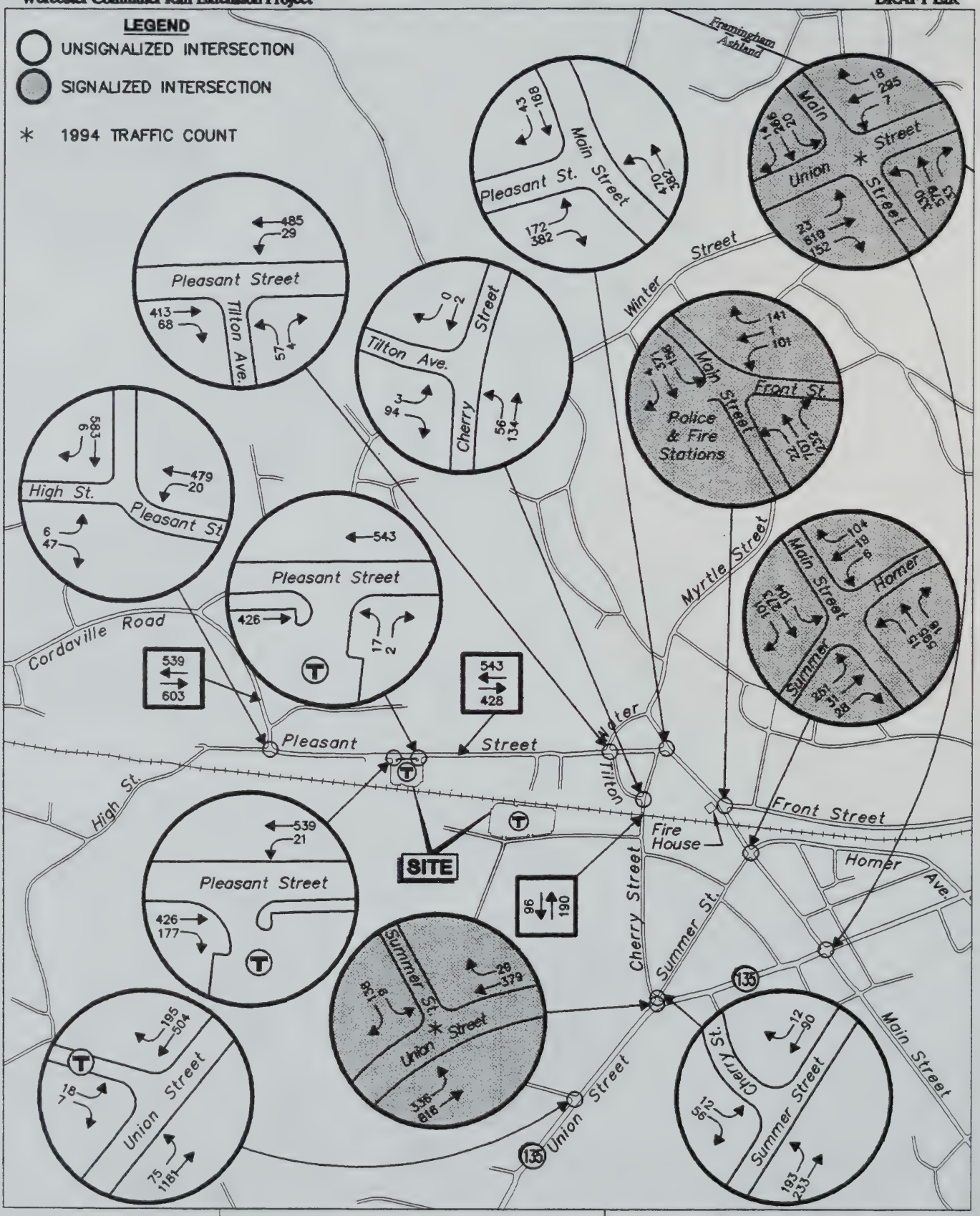


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD Ashland Only
ASHLAND STATION-EAST

FIGURE 1.8-17

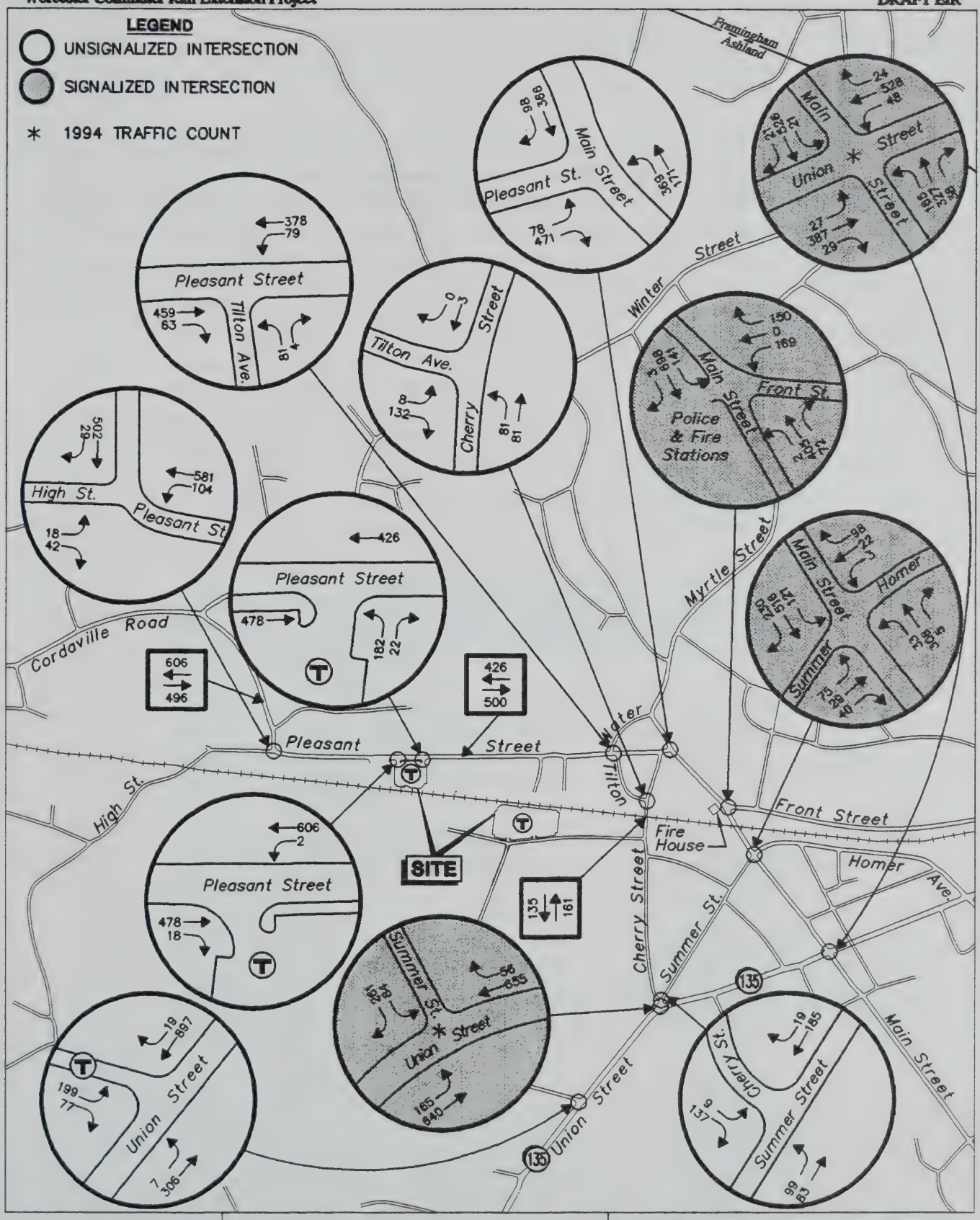


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1996 BUILD Ashland Only
ASHLAND STATION-EAST

FIGURE 1.8-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 BUILD Ashland Only
ASHLAND STATION-EAST

FIGURE 1.8-19

this assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 1996 "No Build" conditions were not changed from the existing conditions. For the 1996 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.8-15 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 1996 "No Build" and "Build" Ashland Station Only conditions. Under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at an overall acceptable level of service. During the A.M. peak hour, the northbound approach of Main Street would operate at a LOS rating of "E". During the P.M. peak hour, the southbound approach of Main Street would operate at a LOS rating of "E".

Table 1.8-15 1996 Peak Hour Signalized Intersection Levels of Service (Ashland Station Only)

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(32.2)	D(33.6)	B(10.9)	C(21.1)
Westbound	C(23.2)	D(25.3)	D(33.5)	F(60.6)
Northbound	E(48.7)	C(15.7)	B(10.0)	A(4.5)
Southbound	B(9.4)	E(47.1)	A(2.3)	C(15.8)
Main with Summer	E(42.3)	B(13.8)	E(56.2)	B(7.5)
Eastbound	F(68.8)	C(18.9)	F(139)	D(24.2)
Westbound	C(17.1)	C(17.0)	C(21.6)	C(15.8)
Northbound	B(13.3)	B(7.9)	B(14.9)	A(2.9)
Southbound	F(68.1)	B(14.9)	F(68.3)	B(5.2)
Main with Union	F*	D(28.4)	D(32.0)	E(41.7)
Eastbound	F*	C(17.8)	D(36.4)	E(54.8)
Westbound	B(8.0)	E(58.2)	B(8.8)	E(40.5)
Northbound	C(15.8)	B(12.6)	E(43.1)	E(46.9)
Southbound	B(7.2)	C(16.0)	B(13.9)	C(23.7)
Union with Summer	F*	F*	D(25.2)	F(92.8)
Eastbound	F*	B(13.6)	C(18.0)	E(47.6)
Westbound	F(66.8)	F*	D(29.4)	F(114)
Southbound	B(14.2)	E(64.9)	F(64.7)	F(150)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the 1996 "Build" Ashland Station Only condition, the Main Street/Front Street intersection would operate at an overall acceptable level of service rating if the signal timings are optimized in both the A.M. and P.M. peak hours. Only the westbound approach will see an unacceptable LOS rating of "F" and only in the P.M. peak hour.

Under the 1996 "No Build" condition, the Main Street/Summer Street intersection would operate at an acceptable LOS rating on all approaches during the P.M. peak hour. During the A.M. peak hour, the intersection would operate at an overall LOS rating of "E" with the eastbound approach of Summer Street and the southbound approach of Main Street operating at A LOS rating of "F".

Under the 1996 "Build" condition, the Main Street/Summer Street intersection with optimized timing, would operate at LOS "E" in the A.M. peak hour with both the eastbound and southbound approaches at LOS "F". During the P.M. peak hour, the intersection will function at LOS "B" with all approaches operating acceptably,.

In the "No Build" condition, the Main Street/Union Street intersection will function at an unacceptable LOS "F" in the A.M. peak hour. The eastbound approach will also operate at LOS "F". In the P.M. peak hour the intersection operates acceptably. The westbound approach will be at LOS "E".

With optimization of the signal timing, the intersection will improve to LOS "D" in the A.M. peak hour "Build" condition. The northbound approach will operate at LOS "E". Level of service will decline to LOS "E" in the P.M. peak hour with three approaches also operating at LOS "E".

In the "No Build" condition, the Union Street/Summer Street intersection will operate at LOS "F" in both peak hours. Both the eastbound and westbound approaches will function at LOS "F".

In the "Build" condition, operations at the intersection can be improved to an acceptable level of service in the A.M. peak hour by improving the signal timing. In the P.M. peak hour, level of service will be reduced to LOS "E". Three of the approaches will also operate at LOS "E" in the P.M. peak hour.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" Ashland Station Only conditions using the same methodology as with the existing conditions analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" Ashland Station Only conditions are listed in Table 1.8-16. Under the 1996 "No Build" conditions, most of the intersection movements would operate at an acceptable level of service. The northbound left and

right turn movements from Tilton to Pleasant Street would operate at a LOS rating of "E" during both the A.M. and P.M. peak hours. The eastbound left turn movement from Pleasant Street onto Main Street would operate at a LOS rating of "F" during both the A.M. and P.M. peak hours.

Table 1.8-16 1996 Peak Hour Unsignalized Intersection Level of Service (Ashland Station Only)

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(635)	A(442)	A(552)	A(433)
LT and RT from High	B(342)	D(150)	C(274)	D(112)
Pleasant with Site's West DW				
LT from WB Pleasant	-	-	A(548)	A(592)
Pleasant with Site East DW				
LT from Parking Lot	-	-	D(128)	F(-5)
RT from Parking Lot	-	-	A(515)	A(468)
Pleasant with Tilton				
LT from WB Pleasant	A(601)	A(507)	A(600)	A(495)
LT and RT from Tilton	E(95)	E(26)	E(91)	E(21)
Main with Pleasant				
LT from NB Main	A(493)	B(304)	A(489)	B(303)
LT from Pleasant	F(-81)	F(-4)	F(-84)	F(-16)
RT from Pleasant	A(429)	D(144)	A(429)	D(138)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1070)	A(1121)	A(1070)
LT and RT from Tilton	A(949)	A(848)	A(949)	A(848)
Summer with Cherry				
LT from EB Summer	A(855)	A(785)	A(853)	A(785)
LT and RT from SB Cherry	A(712)	A(590)	A(710)	A(590)
THRU and RT from WB Summer	A(447)	B(341)	A(445)	B(340)
Union with Site's South DW				
LT from EB Union	-	-	A(513)	B(336)
LT from Parking Lot	-	-	E(23)	F(-106)
RT from Parking Lot	-	-	A(477)	D(198)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, most of the analyzed intersections would operate at acceptable levels of service. The northbound left and right turns from Tilton Street to Pleasant Street would operate at a LOS rating of "E" during the A.M. and P.M. peak hours. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS rating of "F" during both the A.M. and P.M. peak hours.

In addition to the intersections analyzed under the 1992 existing and 1996 "No Build" scenarios, the intersections of the proposed station access driveways to Pleasant Street or Union Street were analyzed under the 1996 "Build" conditions. As shown in Table 1.8-16, generally the movements at these intersections would operate at an acceptable level of service during both the A.M. and P.M. peak hours. The southbound left turns from the south driveway to eastbound Union Street will have A.M./P.M. peak hour LOS ratings of "E"/"F", and the in the P.M. peak hour the northbound left turning traffic from the east driveway to westbound Pleasant Street will see a LOS rating of "E".

Road Segments

The roadway segments discussed in the existing conditions wee also analyzed for level of service under the 1996 "No Build" and "Build" Ashland Station Only conditions. Table 1.8-17 lists the results of this analysis for the A.M. and P.M. peak hours.

Table 1.8-17 1996 Peak Hour Road Segment Level of Service (Ashland Station Only)

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1151)	E(1160)	E(1052)	E(961)
Pleasant Street East of Site	D(1284)	D(1296)	D(1295)	D(1274)
Cherry Street at Railroad Grade Crossing	C(1713)	C(1802)	C(1590)	C(1638)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table in the "No Build" condition, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS rating of "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,100 additional vehicles before reaching capacity.

The Cherry Street road segment was selected for analysis due to the existing at-grade railroad crossing. Closing of the gates due to train crossings reduces the capacity of

the roadway proportional to the length of time the traffic is stopped. As seen in Table 1.8-17, the stopping of traffic for train crossing does not have a significant impact on the flow of traffic along Cherry Street.

Under the 1996 "Build" condition, only the Cordaville Road segment west of the site in the A.M. and P.M. roadway peak hours would operate at a level of service rating of "E". Although this roadway segment is listed as a LOS rating of "E" the segment can accommodate an additional 950 vehicles or more before reaching capacity.

Year 1996 Peak Generator Hour Level of Service (Ashland Station Only)

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.8-18 for the 1996 "No Build" and "Build" conditions.

As shown in the table, under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at a LOS rating of "D" or better during the A.M. and P.M. peak hours. The northbound approach of Main Street would operate at a LOS rating of "E". The Main Street/Summer Street intersection would operate at acceptable levels of service an all approaches during the P.M. peak generator hour. During the A.M. peak generator hour, the intersection would operate at an overall LOS rating of "D", with the eastbound Summer Street approach operating at a LOS rating of "F".

In the P.M. peak generator hour all the approaches of the Main Street/Union Street intersection will be operating at acceptable LOS ratings. In the A.M. peak generator hour the overall LOS rating for this intersection will be F*, this is due to the eastbound Union Street LOS rating being F*. The intersection of Union Street with Summer Street will see both the A.M. and P.M. peak generator hour overall LOS rating of "F*". In the A.M. peak generator hour it is the eastbound Union Street approach which has the "F*" rating. In the P.M. peak generator hour it is the eastbound Union Street traffic which has the "F*" LOS rating. In addition to the approaches having a LOS rating of "F*", the westbound Union Street has a LOS rating of "F" in the A.M. peak generator hour and the southbound Summer Street approach will have a LOS rating of "E" in the P.M. peak generator hour.

Under the "Build" condition, during the A.M. peak generator hour, the Main Street/Front Street intersection would operate at an overall acceptable LOS rating in both the A.M. and P.M. peak generator hours. The westbound Front Street approach will see a LOS rating of "E" in the P.M. peak generator hour. In the P.M. peak generator hour the Main Street/Summer Street intersection will be operating at acceptable LOS ratings on all approaches. In the A.M. peak generator hour the

overall LOS rating will be "E", due to the eastbound Summer Street approach LOS rating being "F" and the southbound Main Street approach LOS rating being an "E". The intersection of Main Street/Union Street will see an overall LOS rating of "E" in both the A.M. and P.M. peak generator hours. This is due to the northbound Main Street approach's A.M. and P.M. peak generator LOS rating being "E" and the eastbound Union Street approach's LOS rating being "E" and "F" in the A.M. and P.M. peak generator hours, respectively. At the intersection of Union Street/Summer Street, the overall LOS rating will be "D" in the A.M. peak generator hour and an unacceptable "F" in the P.M. peak generator hour. The westbound Union Street approach will have a LOS rating of "E" in the A.M. peak generator hour, while the southbound Summer Street approach will have a LOS rating of "F". During the P.M. peak generator hour all of the approaches will see a LOS rating of "E" or "F".

As with the 1992 existing conditions analysis, the approach capacities used for the analysis of the intersections of Main Street with Front Street and Main Street with Summer Street and Homer Avenue were adjusted to account for the additional railroad gate closings. The signal timings were optimized to account for the changes in traffic volumes.

Table 1.8-18 1996 Peak Generator Hour Signalized Intersection Levels of Service (Ashland Station Only)

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(33.2)	D(28.9)	B(9.3)	C(17.5)
Westbound	C(22.8)	D(25.5)	D(29.8)	E(47.6)
Northbound	E(49.6)	B(14.3)	B(8.1)	A(4.5)
Southbound	B(8.3)	D(38.1)	A(2.1)	B(13.0)
Main with Summer	D(35.2)	C(17.7)	E(47.4)	B(7.5)
Eastbound	F(86.3)	C(18.5)	F(117)	D(25.5)
Westbound	C(16.6)	C(16.7)	C(16.7)	C(15.7)
Northbound	B(13.5)	B(7.7)	C(16.5)	A(2.5)
Southbound	D(35.9)	C(21.4)	E(51.6)	B(5.5)
Main with Union	F*	C(19.5)	E(40.3)	E(44.0)
Eastbound	F*	C(16.7)	E(56.1)	F(71.0)
Westbound	B(8.0)	D(32.9)	B(11.9)	D(25.4)
Northbound	C(15.8)	B(10.2)	E(45.7)	E(50.6)
Southbound	B(7.2)	B(14.6)	B(14.8)	D(25.1)
Union with Summer	F*	F*	D(37.7)	F(81.7)
Eastbound	F*	B(13.0)	D(25.9)	E(42.5)
Westbound	F(63.9)	F*	E(45.7)	F(98.8)
Southbound	B(14.2)	E(42.5)	F(95.6)	F(136)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.8-19. Under the 1996 "No Build" conditions, the analyzed intersections would for the most part operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS rating of "E" during the P.M. peak generator hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS rating of "F" and a LOS rating of "E" during the A.M. and P.M. peak generator hours, respectively.

Table 1.8-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Ashland Station Only)

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(627)	A(464)	A(496)	A(451)
LT and RT from High	B(333)	D(160)	C(229)	D(104)
Pleasant with Site's West DW				
LT from WB Pleasant	-	-	A(562)	A(660)
Pleasant with Site East DW				
LT from Parking Lot	-	-	D(160)	E(17)
RT from Parking Lot	-	-	A(590)	A(531)
Pleasant with Tilton				
LT from WB Pleasant	A(645)	A(579)	A(644)	A(562)
LT and RT from Tilton	D(129)	E(97)	D(122)	E(89)
Main with Pleasant				
LT from NB Main	A(506)	A(417)	A(499)	A(416)
LT from Pleasant	F(-71)	E(57)	F(-76)	E(42)
RT from Pleasant	A(463)	C(200)	A(462)	D(192)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1096)	A(1121)	A(1096)
LT and RT from Tilton	A(954)	A(900)	A(954)	A(900)
Summer with Cherry				
LT from EB Summer	A(874)	A(858)	A(869)	A(858)
LT and RT from SB Cherry	A(696)	A(679)	A(692)	A(678)
THRU and RT from WB Summer	A(457)	A(434)	A(452)	A(432)
Union with Site's South DW				
LT from EB Union	-	-	A(443)	B(388)
LT from Parking Lot	-	-	E(9)	F(-88)
RT from Parking Lot	-	-	A(461)	C(226)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" the Ashland Station only conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS rating of "E" during the P.M. peak generator hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS rating of "F" during the A.M. peak generator hour, and at a LOS rating of "E" during the P.M. peak generator hour.

The intersections of the site driveways along Pleasant Street and Union Street would generally operate at an acceptable level of service during both the A.M. and P.M. peak generator hours. The left turning traffic from the south driveway heading east on Union Street will have an A.M./P.M. LOS rating of "E"/"F", respectively.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for levels of service under the 1996 "No Build" and "Build" Ashland Station Only conditions. Table 1.8-20 lists the results of this analysis for the A.M. and P.M. peak generator hours.

Table 1.8-20 1996 Peak Generator Hour Road Segment Level of Service (Ashland Station Only)

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1221)	D(1347)	E(1055)	E(1148)
Pleasant Street East of Site	D(1339)	D(1481)	D(1370)	D(1575)
Cherry Street at Railroad Grade Crossing	C(1684)	C(1834)	D(1511)	C(1712)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table, for the "No Build" condition all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS rating of "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,200 additional vehicles before reaching the LOS rating of "F".

Under the "Build" Ashland Station Only conditions, all roadway segments during the A.M. and P.M. peak generator hours would operate at an acceptable level of service. Although several roadway segments of Cordaville Road west of the site is listed as a LOS rating of "E", this road segment accommodates an additional 1,250 vehicles or more before reaching capacity.

The roadway segment analysis performed for Cherry Street at the railroad crossing demonstrates that additional gate closing during the peak generator hours do not significantly impact the flow of traffic along Cherry Street.

Year 1996 Ten Percent of Traffic Analysis (Ashland Station Only)

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.8-21 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in the Table 1.8-21, four intersections would have 10 percent or more of their traffic from the proposed rail station during the roadway peak hours. The intersections are:

- Pleasant Street with High Street
- Pleasant Street with Site's West Driveway
- Pleasant Street with Site's East Driveway
- Pleasant Street with Site's South Driveway

One roadway segment would receive over 10 percent from the proposed rail station. Cordaville Road, west of the site's driveways, would exceed the 10 percent criteria during the A.M. and P.M. peak hours.

The portion of total "Build" traffic exceeding 10 percent ranges from 10.4 percent to 13.3 percent.

Table 1.8-21 1996 Condition - 10% Analysis (Ashland Station Only)

Intersection	Peak Hours	
	A.M.	P.M.
Pleasant with High	12.3%	12.2%
Pleasant and Site's West Driveway	11.8%	12.9%
Pleasant and Site East Driveway	2.1%	13.3%
Pleasant and Tilton	1.1%	1.5%
Main and Pleasant	0.8%	1.1%
Main and Front	0.2%	0.4%
Main and Summer	0.0%	0.0%
Main and Union	6.1%	6.4%
Cherry with Tilton	0.0%	0.0%
Summer with Cherry	0.3%	0.5%
Union with Summer	7.4%	8.9%
Union with Site's South Driveway	10.4%	9.6%
Roadway Segment		
Cordaville Rd. West of Site	10.7%	12.7%
Pleasant St. East of Site	1.2%	1.7%
Cherry St. at Railroad Crossing	0.0%	0.0%

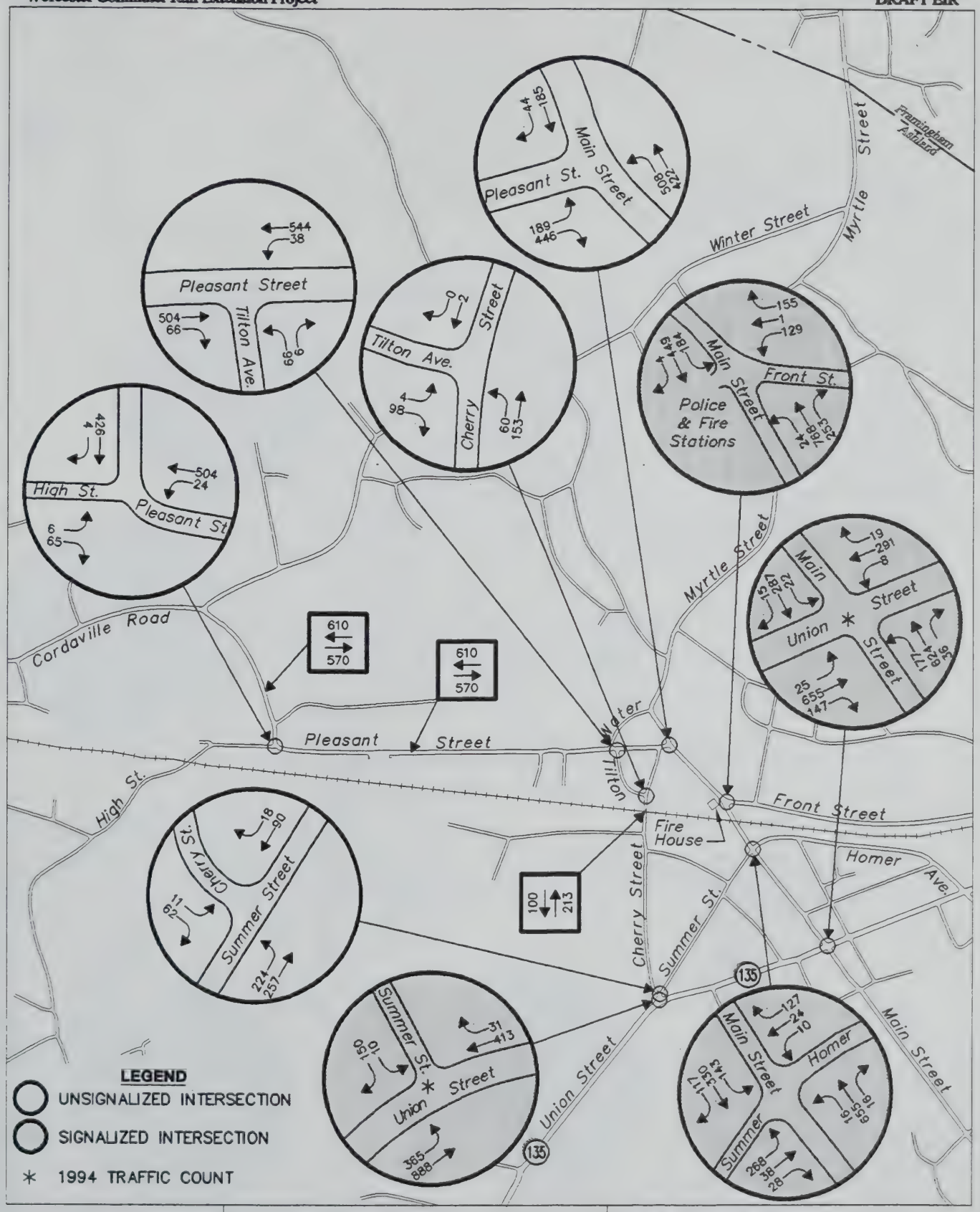
Site generated traffic as a percentage of total traffic

Year 2001 Conditions

Similar to the year 1996 conditions, an analysis was performed for the projected "No Build" and "Build" traffic conditions in the year 2001. Procedures and methodology for this analysis were the same as in the 1996 condition analysis. A detailed description of the analysis methodology is presented in Section 1.1 of this report.

Year 2001 "No Build" Traffic Volumes

To determine the year 2001 "No Build" traffic volumes, the traffic volumes under the 1996 "No Build" conditions were adjusted based on anticipated growth in population and employment throughout the region. A growth rate of 1.5 percent per year was applied to the 1996 "No Build" traffic volumes. At this time, no significant developments are planned proximate to the study area. Figures 1.8-20 and 1.8-21

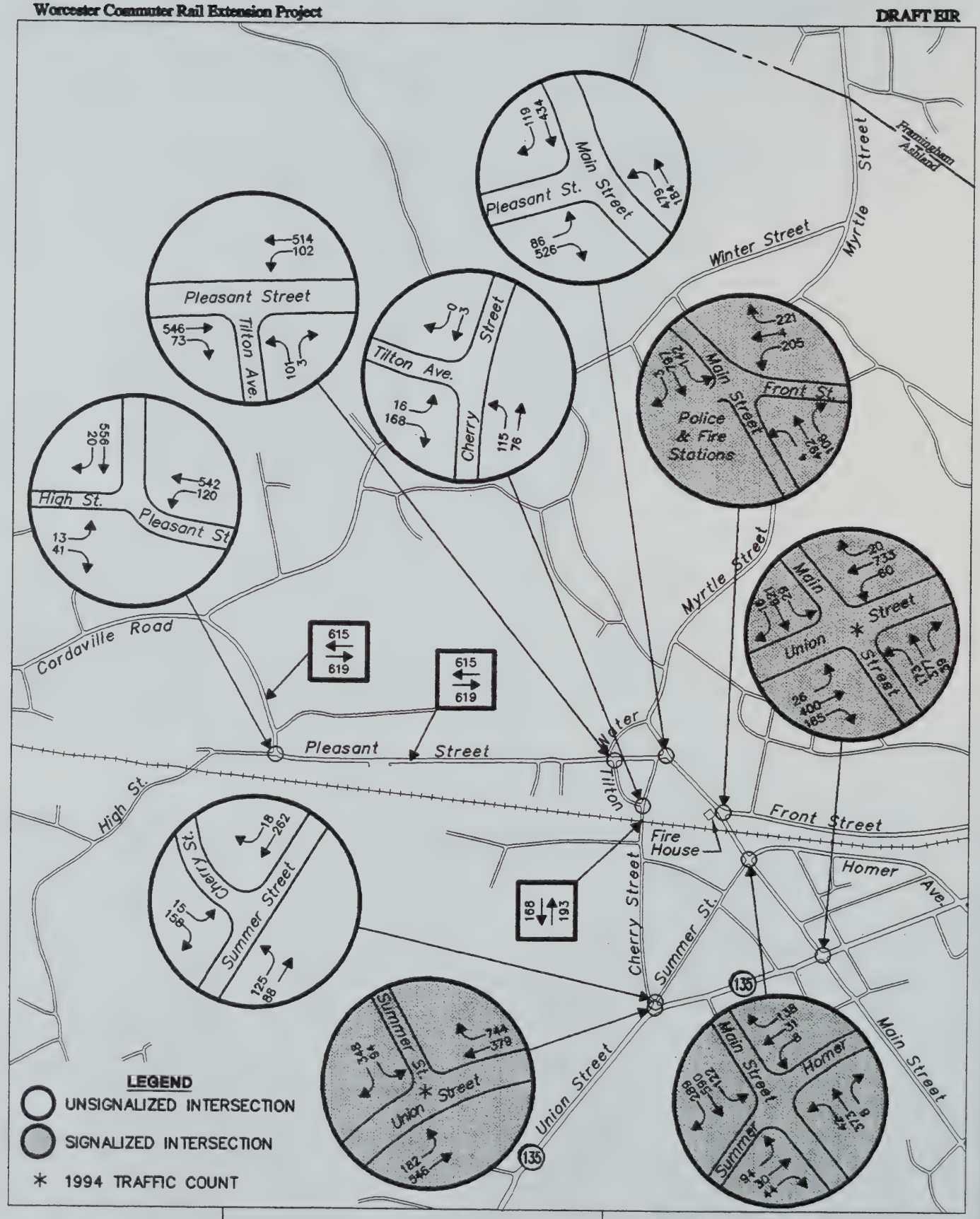


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-20



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
2001 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-21

show the projected 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. roadway peak hour. Figures 1.8-22 and 1.8-23 show the projected year 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak generator hours.

Year 2001 Trip Generation/Parking

Minor shifting is expected to occur in the town of origin of the patrons utilizing the proposed Ashland Station as presented in the 1996 conditions. The Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension in the year 2001. CTPS projected that a total of 2,300 persons are expected to utilize the railroad for daily round trip commuting into Boston. The proposed Ashland station is projected to attract 837 of these commuters. Twenty of these patrons would walk to the station, and 65 would be dropped off. Based upon an average automobile occupancy rate of 1.12, the 752 remaining patrons would result in a parking demand of 671 spaces.

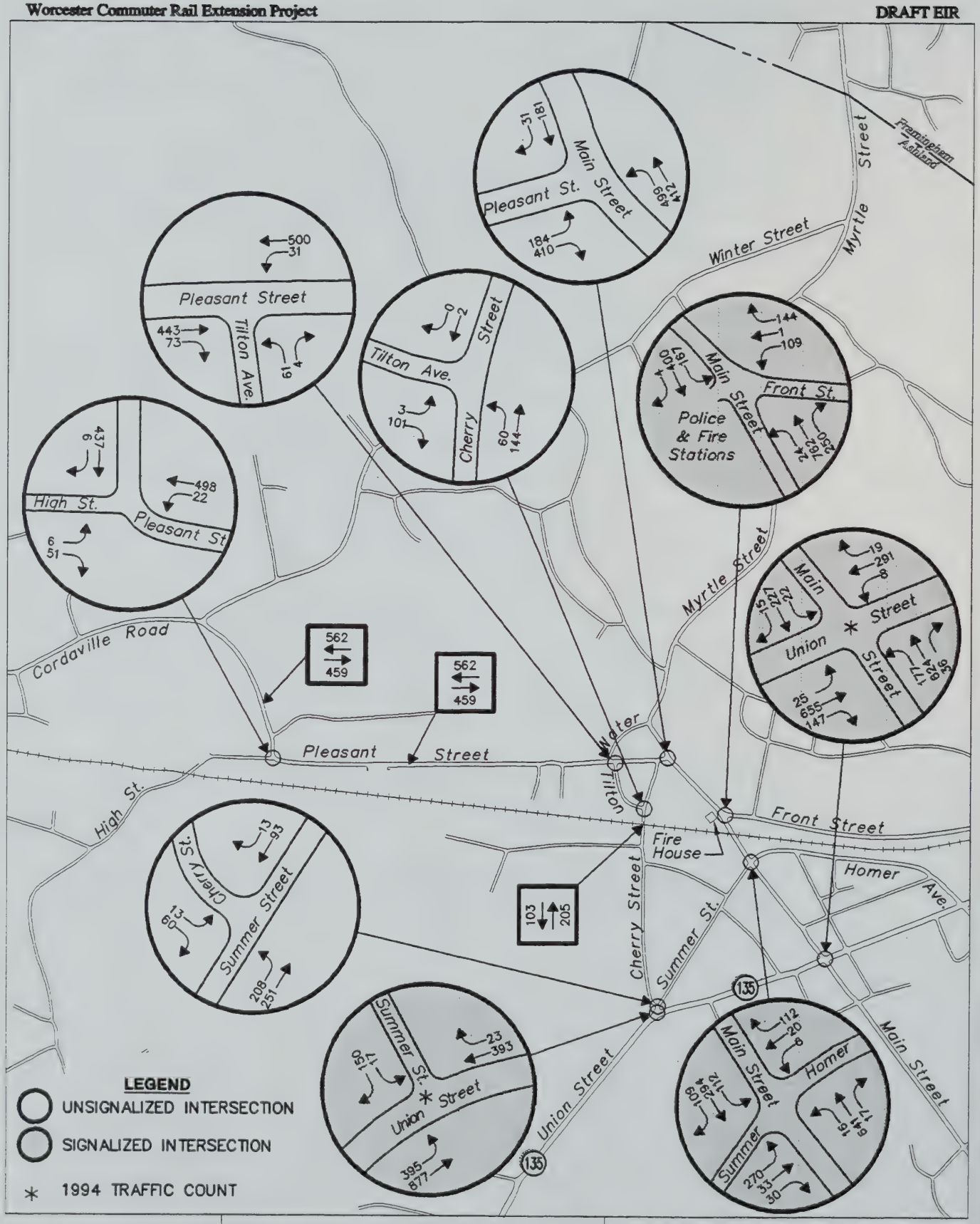
These patrons are projected to reside in the Towns of Ashland, Holliston, Hopkinton, Marlborough, Southborough, Upton, and Westborough. Based on the station's proposed location, all 20 of the patrons who walk to the station will originate in the Town of Ashland. The number of peak period commuting patrons originating from each Town are shown in Table 1.8-22.

Six percent of the total ridership is expected to occur outside of the peak A.M. and P.M. commuting periods, thus the 837 daily ridership was reduced to 788 riders during the peak commuting hours.

Table 1.8-22 Projected Patrons of Ashland Station - Year 2001

Town	Riders*
Ashland	393**
Holliston	281
Hopkinton	50
Marlborough	24
Southborough	29
Upton	7
Westborough	4
Total	**788**

* *Adjusted for peak period demand*
** *Includes 19 walk trips from Ashland*

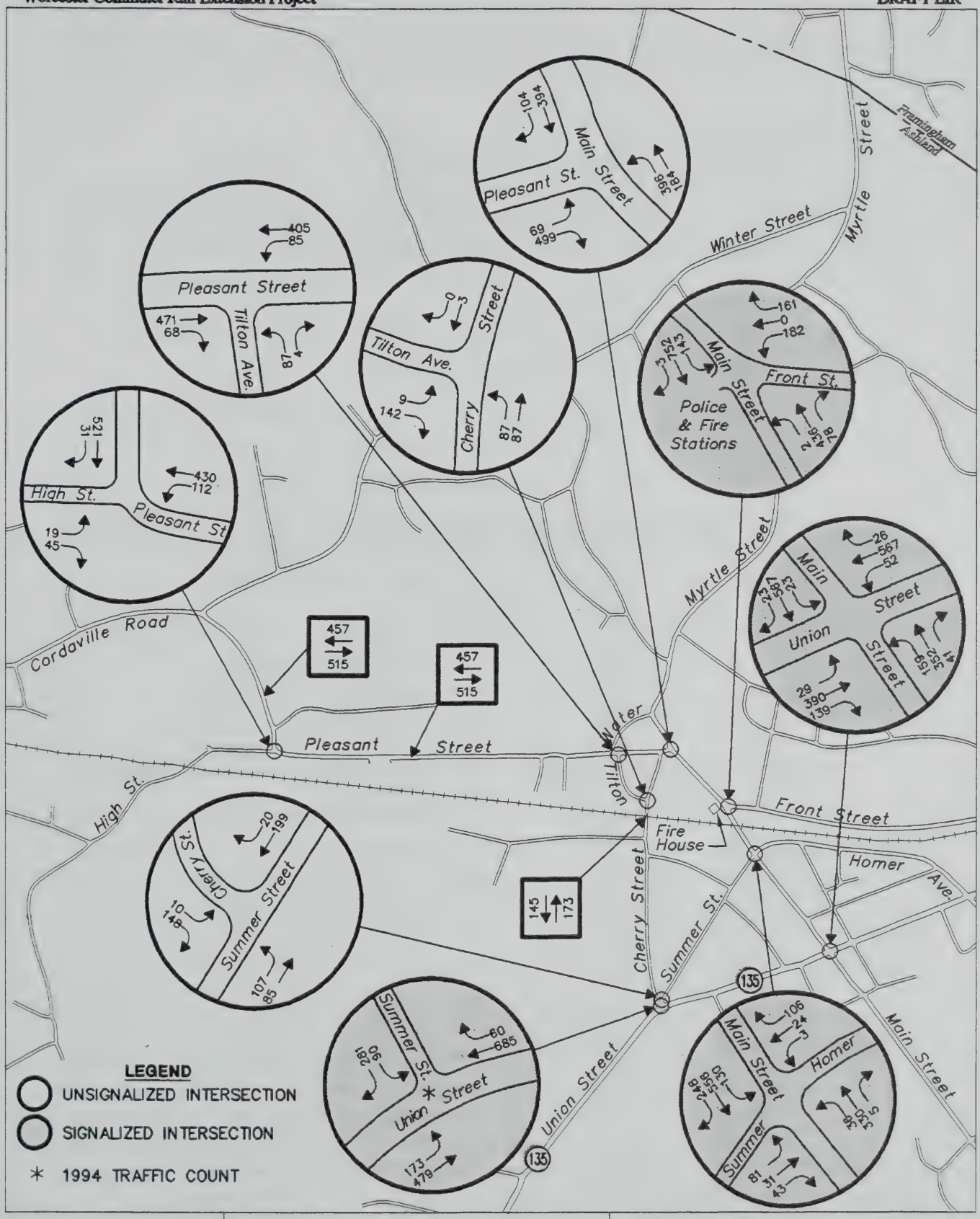


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
2001 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-22



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
2001 NO BUILD
ASHLAND STATION-EAST

FIGURE 1.8-23

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, of even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier of later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand the those that depart at other times.

The distribution of ridership per train is the same as under the 1996 conditions. Table 1.8-23 lists the typical distribution of ridership based on arrival/departure time in Boston.

Table 1.8-23 MBTA Ridership Distribution

Inbound Train	Patrons
502A	154
504A	256
506A	256
510	122
Total	**788**
Outbound Train	**Patrons**
515A	110
519A	183
521	182
521A	274
523	39
Total	**788**

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Ashland would utilize a variety of travel routes, depending on the location of their residence. Due to the minor shifts in town of origin of the patrons addressed previously, the percentage of site generated traffic on the study area roadways is slightly different than under the 1996 conditions.

Riders originating in towns outside that in which the station is located were assigned to major roadways. Patrons from Marlborough, Southborough, and Westborough

would access the station via Cordaville Road. Patrons from Holliston, Hopkinton, and Upton would access the station via Union Street.

Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.8-24 shows the percentage of station related traffic utilizing the study area roadways.

Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Ashland rail station.

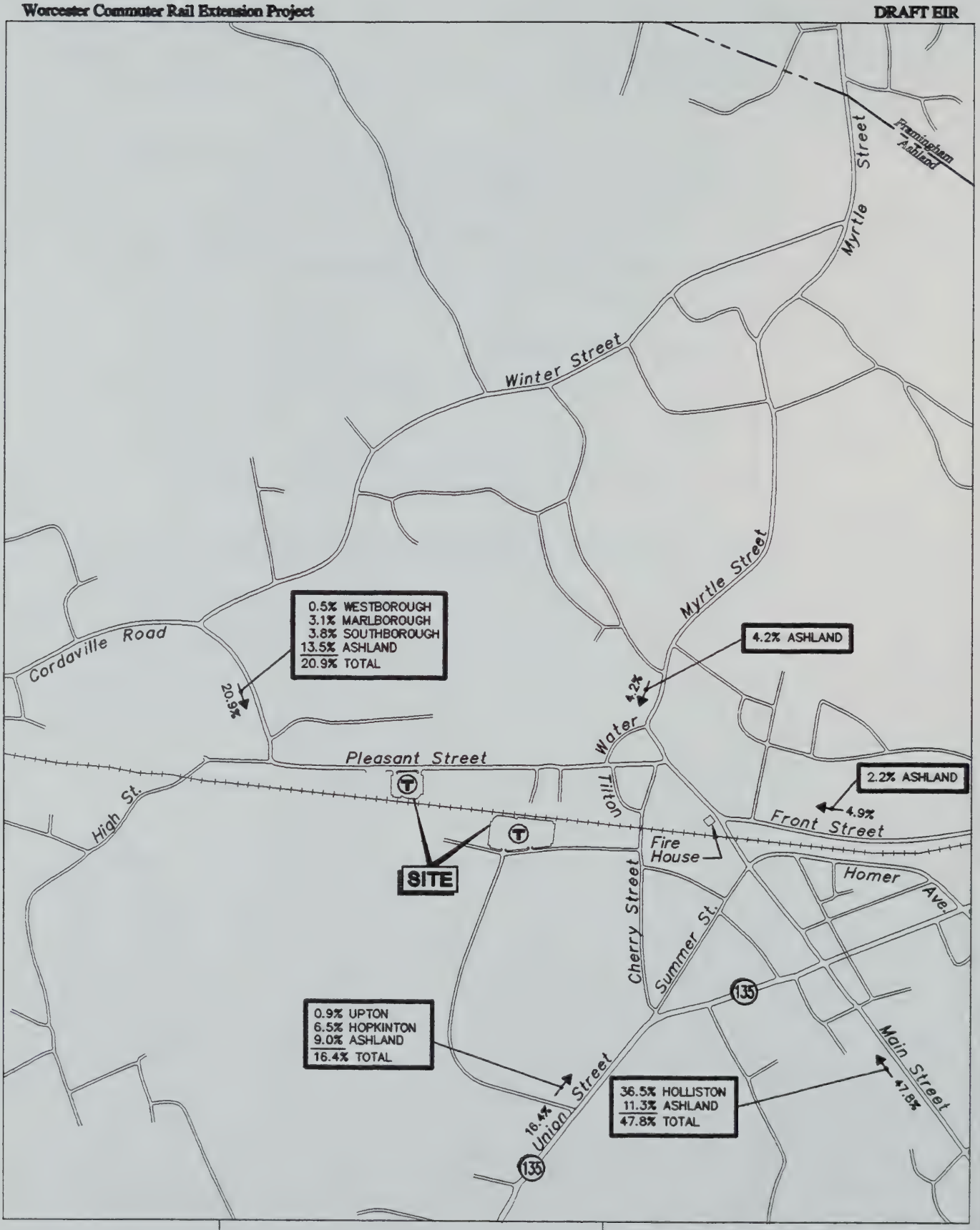
A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Ashland Center, which includes Pleasant Street. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways including Pleasant Street. This results in a "worst case" analysis. Figures 1.8-25 and 1.8-26 show the A.M. and P.M. peak roadway hour traffic volumes respectively. Figures 1.8-27 and 1.8-28 show the A.M. and P.M. peak generator hour volumes.

Year 2001 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing and 1996 "No Build" conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. The traffic volumes are the only parameter in the analysis that changes from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 2001 "No Build" condition were not changed from the existing conditions. For the 2001 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.8-24 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 2001 "No Build" and "Build" conditions. Under the 2001 "No Build" conditions, the Main Street/Front



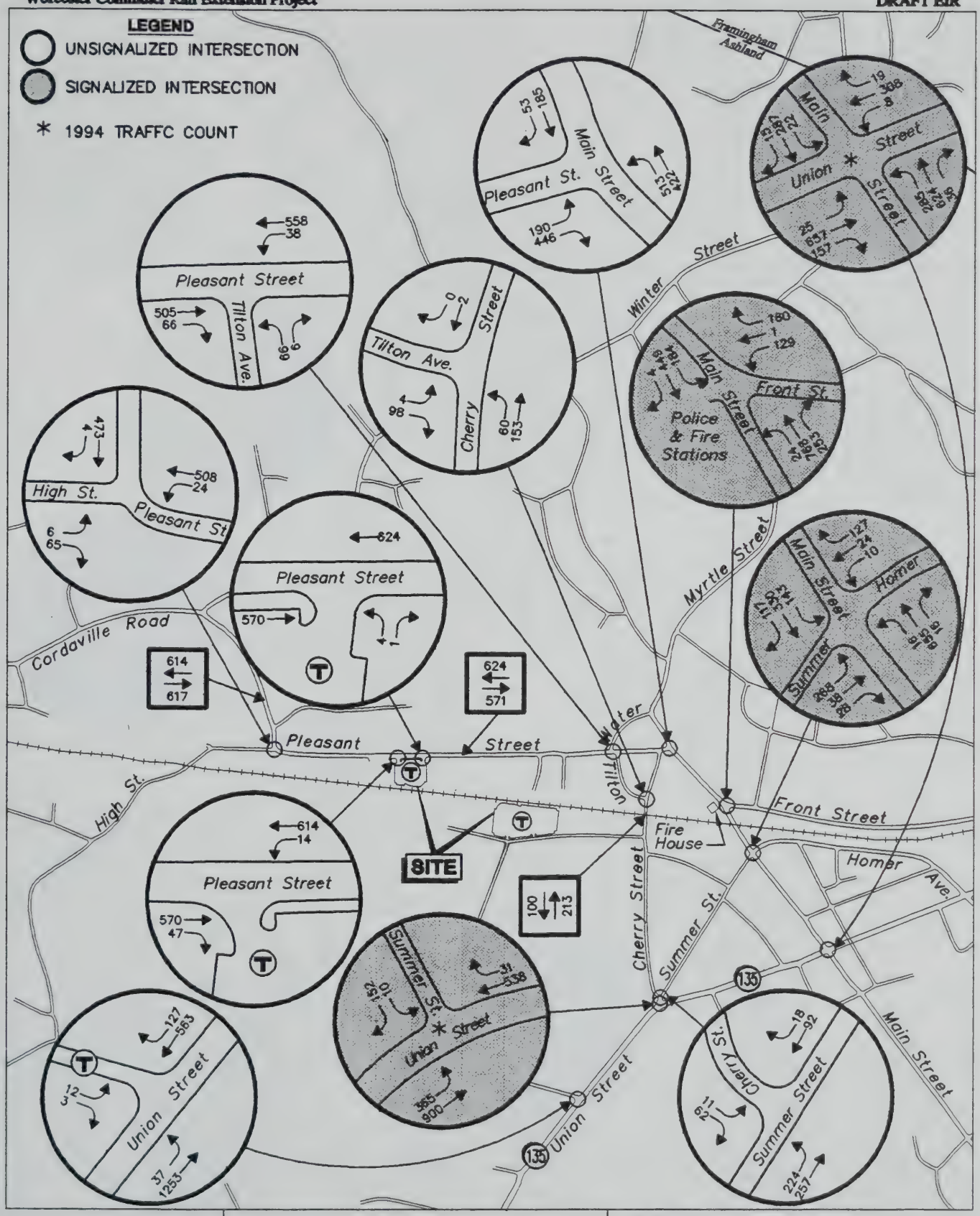
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-24



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
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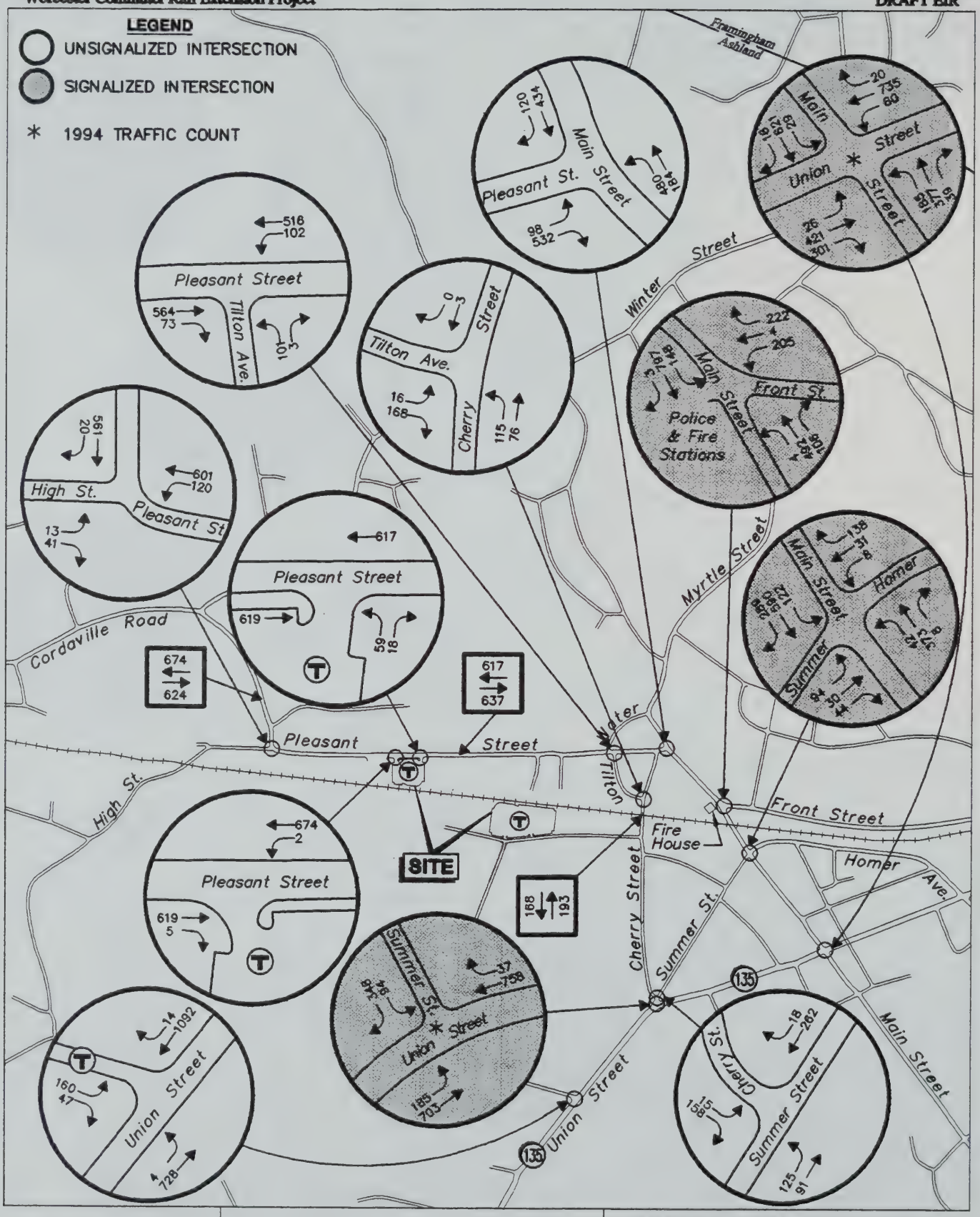
A.M. Peak Hour
7:30 - 8:30 A.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-25



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

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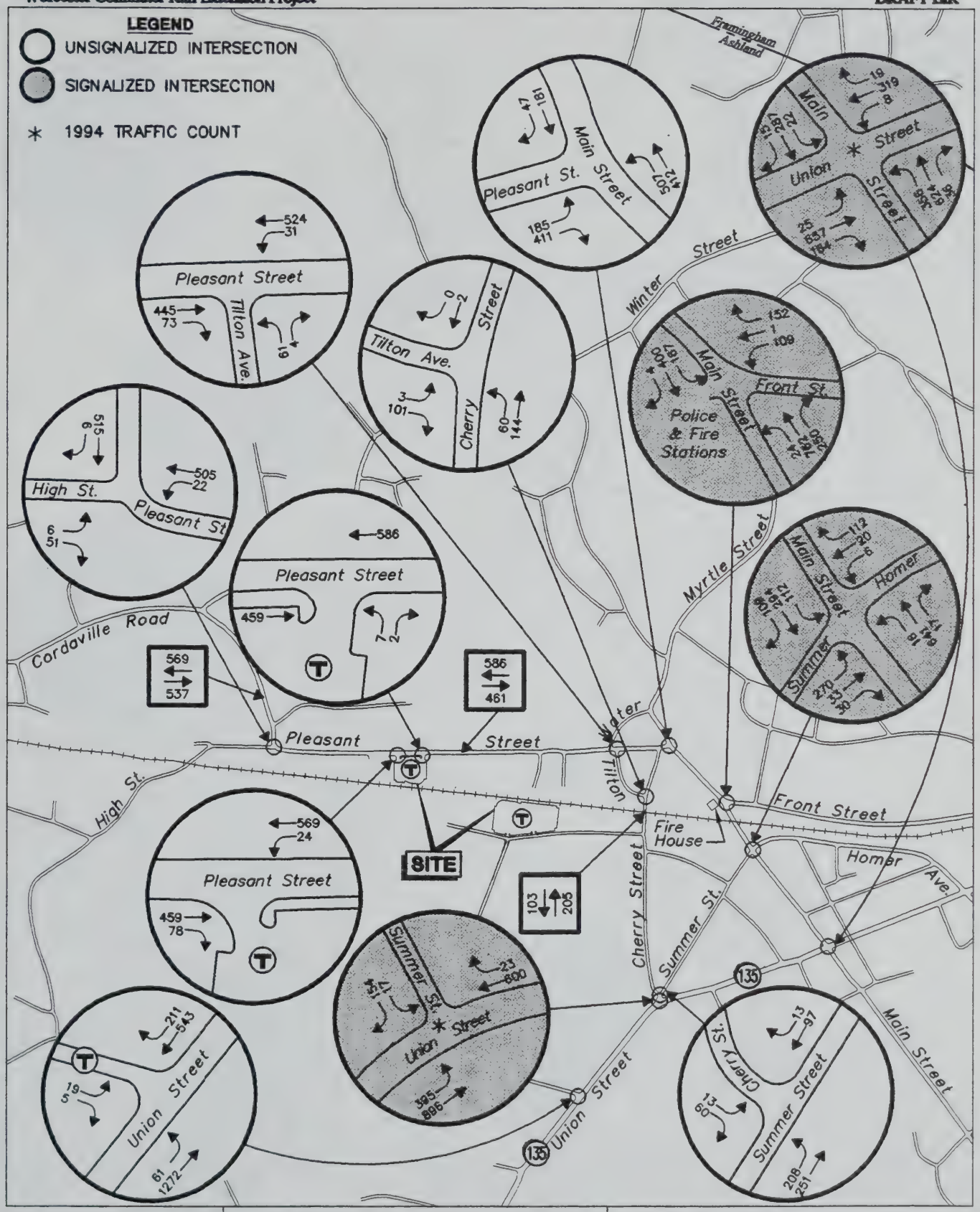
P.M. Peak Hour
5:00 - 6:00 P.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-26



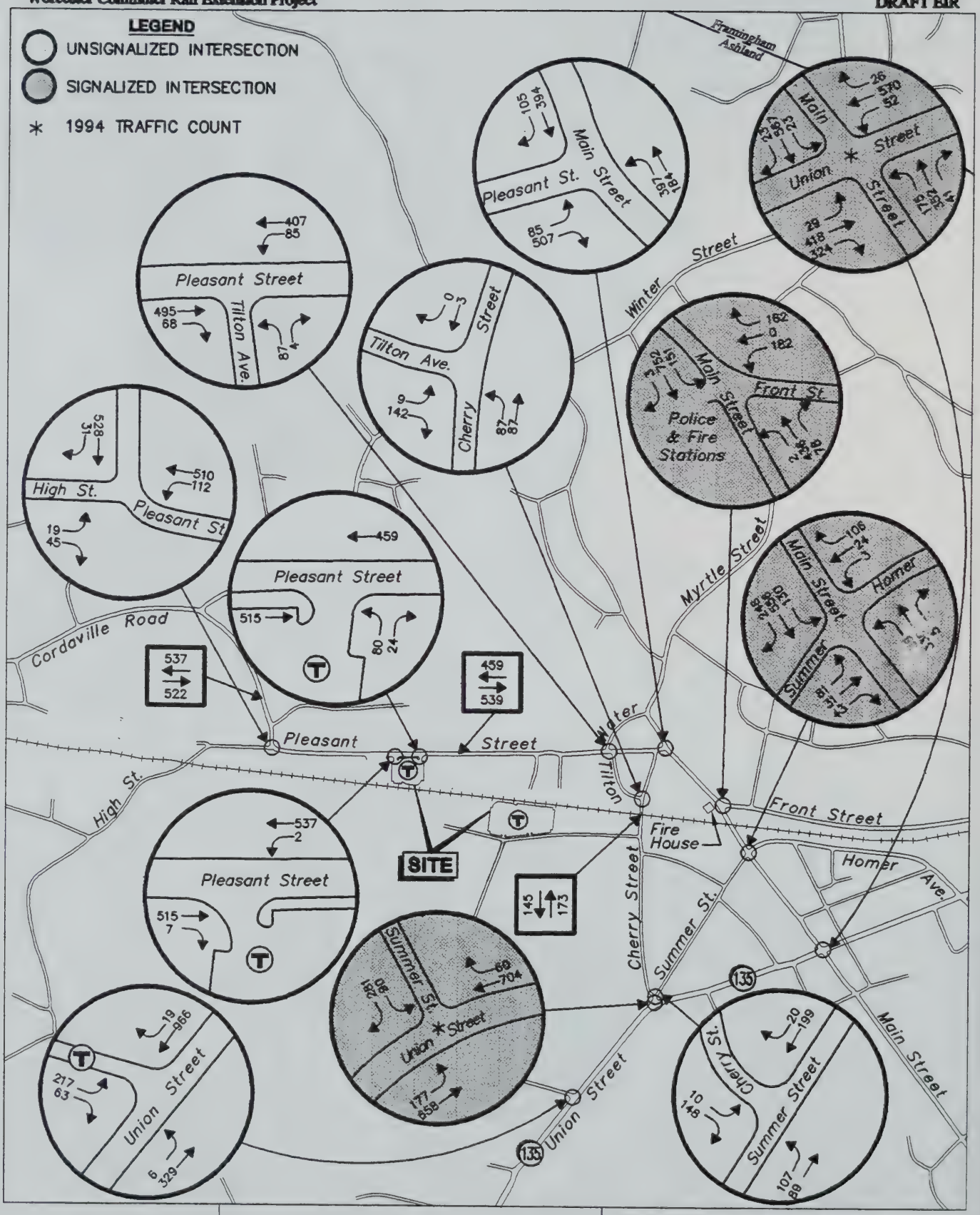
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-EAST

FIGURE 1.8-28

Street intersection would operate at level of service rating of "E" in the A.M. and P.M. peak hours. The "E" overall LOS rating is due to the northbound Main Street approach in the A.M. peak hour and the southbound Main Street approach in the P.M. peak hours having a LOS rating of "F".

Table 1.8-24 2001 Peak Hour Signalized Intersection Levels of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	E(46.5)	E(43.3)	B(12.0)	D(30.7)
Westbound	C(23.5)	D(25.9)	D(38.9)	F(75.5)
Northbound	F(74.2)	C(17.4)	B(10.1)	B(5.2)
Southbound	B(11.9)	F(65.3)	A(2.9)	D(28.5)
Main with Summer	F*	C(19.9)	F*	B(9.4)
Eastbound	F(95.8)	C(19.4)	F*	D(29.1)
Westbound	C(17.3)	C(17.1)	C(21.9)	C(16.8)
Northbound	C(16.7)	B(9.0)	C(20.6)	A(3.2)
Southbound	F*	C(25.0)	F*	B(7.3)
Main with Union	F*	E(45.6)	E(50.7)	F*
Eastbound	F*	D(25.0)	F(60.3)	F*
Westbound	B(8.2)	F(93.9)	B(9.0)	F*
Northbound	C(22.6)	D(26.9)	F(70.4)	F*
Southbound	B(7.2)	C(22.5)	B(14.5)	C(23.1)
Union with Summer	F*	F*	D(34.6)	F*
Eastbound	F*	B(14.8)	C(24.5)	F*
Westbound	F(101)	F*	E(42.2)	F*
Southbound	B(14.6)	F(99.2)	F(84.8)	F*

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the 2001 "Build" conditions with the retiming of the traffic signals, the Main Street/Front Street intersection would operate at acceptable LOS ratings during both the A.M. and P.M. peak hours. The westbound approach of Front Street would operate at a LOS "F" during the P.M. peak hour.

Under the 2001 "No Build" conditions, the Main Street/Summer Street intersection would operate at LOS "F*" during the A.M. peak hour, with the southbound and eastbound approaches operating at a LOS rating of "F*" and "F". During the P.M. peak hour the overall intersection and all the approaches will be operating an acceptable LOS ratings.

Under the 2001 "Build" conditions with the retiming of the traffic signals, the Main Street/Summer Street intersection would operate at an overall LOS rating of "F*" during the A.M. peak hour. This rating is due to both the eastbound Summer Street approach and southbound Main Street approach having LOS ratings of "F*". During the P.M. peak hour the overall LOS rating and the LOS rating for all the approaches will be acceptable.

Under the 2001 "No Build" conditions, the Main Street/Union Street intersection would operate and the overall LOS rating of "F*" in the A.M. peak hour and "E" in the P.M. peak hour. The A.M. overall "F*" rating is due to the eastbound Union Street approaches "F*" LOS rating. The P.M. overall "E" is due to the westbound Union Street approaches LOS rating of "F".

Under the 2001 "Build" conditions with the signal timings optimized, the Main Street/Union Street overall LOS ratings will be "E" in the A.M. peak hour and "F*" in the P.M. peak hour. The A.M. peak hour overall LOS rating of "E" is due to the eastbound Union Street approach and the northbound Main Street approach having a LOS rating of "F". The P.M. peak hour overall LOS rating of "F*" is due to the eastbound and westbound Union Street and the northbound Main Street approach having "F*" LOS ratings.

Under the 2001 "No Build" conditions, the Union Street/Summer Street intersection would operate at the overall LOS rating of "F*" in both the A.M. and P.M. peak hours. In the A.M. peak hour the overall "F*" LOS rating is caused by the eastbound Union Street approach LOS rating of "F*" and the westbound Union Street approach LOS rating of "F". In the P.M. peak hour the overall "F*" LOS rating is due to the westbound Union Street approach LOS rating of "F*" and the southbound Summer Street approach LOS rating of "F".

Under the 2001 "Build" conditions with the retiming of the traffic signals the Union Street/Summer Street intersection will operate at the overall LOS rating of "D" in the A.M. peak hour and the overall LOS rating of "F*" in the P.M. peak hour. During the A.M. peak hour the westbound Union Street approach will see a LOS rating of "E" and the southbound Summer Street approach will see a LOS rating of "F". During the P.M. peak hour all the approaches will see a LOS rating of "F*".

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis are listed in Table 1.8-25. Under the 2001 "No Build" conditions, the intersection movements would generally operate at acceptable levels of service. The northbound left and right turn movements from Tilton Avenue to Pleasant Street would operate at a LOS rating of "E" during the A.M. peak hour and "F" during the P.M. peak hour. The eastbound left turn movement from Pleasant Street onto Main Street would operate at a LOS rating of "F" during both the A.M. and P.M. peak hours and the eastbound right turn movement will operate at a LOS rating of "E" during the P.M. peak hour.

Under the 2001 "Build" conditions, the analyzed intersections would for the most part operate at acceptable levels of service. The northbound left and right turns from Tilton Street to Pleasant Street would operate at a LOS ratings "E" and "F" during the A.M. and P.M. roadway peak hours, respectively. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" during both the A.M. and P.M. peak hours and the eastbound right turn would operate at a LOS "E" during the P.M. peak hour.

In addition to the intersections analyzed under the 1992 Existing and 2001 "No Build" scenarios, the intersections of the proposed station access driveways to Pleasant Street or Union Street were analyzed under the 2001 "Build" conditions. As shown in the Table, the movements at these intersections would generally operate at acceptable levels of service during both the A.M. and P.M. roadway peak hours. During the A.M. peak hour, the left turn movement from the site's east driveway would operate at a LOS "E". During the A.M. and P.M. peak hours the site's south driveway traffic turning left to eastbound Union Street will have a LOS rating of "E"/"F".

Table 1.8-25 2001 Peak Hour Unsignalized Intersection Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(608)	A(404)	A(572)	A(401)
LT and RT from High	B(314)	D(116)	C(284)	D(101)
Pleasant with Site's West DW				
LT from WB Pleasant	-	-	A(559)	A(567)
Pleasant with Site East DW				
LT from Parking Lot	-	-	D(113)	E(49)
RT from Parking Lot	-	-	A(487)	A(438)
Pleasant with Tilton				
LT from WB Pleasant	A(567)	A(469)	A(567)	A(456)
LT and RT from Tilton	E(66)	F(-2)	E(63)	E(-6)
Main with Pleasant				
LT from NB Main	A(443)	C(243)	A(438)	C(242)
LT from Pleasant	F(-115)	F(-31)	F(-118)	F(-43)
RT from Pleasant	B(383)	E(81)	B(383)	E(75)
Cherry with Tilton				
LT from NB Cherry	A(1117)	A(1062)	A(1117)	A(1062)
LT and RT from Tilton	A(942)	A(832)	A(942)	A(832)
Summer with Cherry				
LT from EB Summer	A(831)	A(757)	A(829)	A(757)
LT and RT from SB Cherry	A(680)	A(557)	A(678)	A(556)
THRU and RT from WB Summer	A(416)	B(300)	A(414)	C(229)
Union with Site's South DW				
LT from EB Union	-	-	A(487)	B(303)
LT from Parking Lot	-	-	E(13)	F(-128)
RT from Parking Lot	-	-	A(449)	D(180)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.8-26 lists the results of this analysis for the A.M. and P.M. peak roadway hours.

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station, and Pleasant Street east of the site are listed as operating at a LOS "E" under the "No Build" and "Build" conditions, there is sufficient reserve capacity to accommodate over 900 additional vehicles before reaching capacity.

Table 1.8-26 2001 Peak Hour Road Segment Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1072)	E(1079)	E(1059)	E(983)
Pleasant Street East of Site	E(1203)	E(1215)	E(1200)	E(1179)
Cherry Street at Railroad Grade Crossing	C(1689)	C(1780)	D(1556)	D(1616)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. As seen in the tables, the stopping of traffic for train crossings does not have a significant impact on the flow of traffic along Cherry Street.

Year 2001 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.8-27 for the 2001 "No Build" and "Build" conditions.

As shown in the table, under the 2001 "No Build" conditions, the Front Street/Main Street intersection would operate at a LOS "E" during the A.M. peak hour, with the northbound approach operating at a LOS "F". During the P.M. peak hour the southbound Main Street approach will operate at a LOS rating of "E".

Table 1.8-27 2001 Peak Generator Hour Signalized Intersection Levels of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	E(47.8)	D(36.8)	B(12.0)	C(24.9)
Westbound	C(23.0)	D(26.0)	D(35.0)	F(61.9)
Northbound	F(75.1)	C(15.2)	B(11.5)	A(5.0)
Southbound	B(9.8)	E(53.1)	A(2.4)	C(21.4)
Main with Summer	F*	D(28.9)	F*	B(9.6)
Eastbound	F(118)	C(18.9)	F*	D(30.7)
Westbound	C(16.7)	C(16.8)	C(20.5)	C(16.4)
Northbound	C(16.9)	B(8.7)	C(22.9)	A(2.7)
Southbound	F*	D(39.6)	F*	B(8.1)
Main with Union	F*	D(29.9)	F(64.2)	F*
Eastbound	F*	C(22.7)	F(106)	F*
Westbound	B(8.2)	E(54.3)	B(13.2)	F*
Northbound	C(22.6)	C(16.9)	F(63.8)	F*
Southbound	B(7.4)	C(19.6)	C(15.0)	D(29.1)
Union with Summer	F*	F*	E(54.4)	F*
Eastbound	F*	B(13.8)	D(36.0)	F*
Westbound	F(97.2)	F*	E(70.9)	F*
Southbound	B(14.5)	F(61.3)	F(128)	F*

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the "Build" condition with the signal retimed the A.M. peak generator hour can see all the approaches operating at acceptable LOS ratings with only the westbound Front Street approach seeing the LOS rating of "F" during the P.M. peak hours.

Under the "No Build" condition the intersection of Main Street/Summer Street will see an overall LOS rating "F*" during the A.M. peak generator hour with an acceptable overall LOS rating during the P.M. peak generator hour. The "F*" rating on the A.M. peak generator hour is caused by the southbound Main Street

approaches LOS rating of "F*" and the eastbound Summer Street approaches LOS rating of "F".

Under the "Build" condition with the signal retimed the overall LOS rating will be "F*" for the A.M. peak generator hour. This is due to the eastbound Summer Street and southbound Main Street LOS rating being "F*".

Under the "No Build" condition the intersection of Main Street/Union Street will have an overall LOS rating of "F*" in the A.M. peak generator hour. The "F*" rating is due to the eastbound Union Street approach having a LOS rating of "F*" During the P.M. peak generator hour only the westbound Union Street approach will see LOS rating of "E".

Under the "Build" condition with signal retiming the overall LOS rating will be "F" and "F*" in the A.M. and P.M. peak generator hours. The A.M. peak generator hour LOS rating of "F" is due to the eastbound and northbound approach is having LOS ratings of "F". The P.M. peak generator hour LOS rating of "F*" is due to the eastbound, westbound, and northbound approach is having a LOS rating of "F*".

Under the "No Build" condition the intersection of Union Street/Summer Street will have an overall LOS rating of "F*" in both the A.M. and P.M. peak generator hours. The A.M. peak generator LOS rating is due to the eastbound Union Street approach having of LOS rating of "F*" and the westbound Union Street approach having a LOS rating of "F". The P.M. peak generator hours LOS rating is due to the westbound Union Street approach LOS rating being "F*" and the southbound Summer Street approach LOS rating being "F".

Under the "Build" condition with signal retimings the A.M. peak generator hour overall LOS rating will be "E" due to the westbound and southbound approaches having a LOS rating of "F". The P.M. peak generator hour overall LOS rating will be "F*" along with all of the approaches.

As with the previous "No Build" and "Build" condition analysis, the approach capacities for analyzing the intersections of Main Street with Front Street and Main Street with Summer Street and Homer Avenue were modified to account for the gate closings of the at-grade railroad crossing separating these intersections.

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.8-28. Under the 2001 "No Build" conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during the P.M. hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" and a LOS "E" during the A.M. and P.M. peak generator hours respectively.

Under the 2001 "Build" conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during both the A.M. and P.M. peak generator hours. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" and a LOS "E" during both the A.M. and P.M. peak hours.

The intersections of the sites driveways with Pleasant Street and Union Street were also analyzed. The left turn movement from the Site's east driveway to westbound Pleasant Street will have a P.M. peak hour LOS rating of "E". The left turn movement from the south driveway to eastbound Union Street will have an A.M. and P.M. peak generator hour LOS ratings of "E" and "F", respectively.

Table 1.8-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(600)	A(428)	A(541)	A(423)
LT and RT from High	B(306)	D(129)	C(259)	D(106)
Pleasant with Site's West DW				
LT from WB Pleasant	-	-	A(606)	A(640)
Pleasant with Site East DW				
LT from Parking Lot	-	-	D(147)	E(95)
RT from Parking Lot	-	-	A(565)	A(502)
Pleasant with Tilton				
LT from WB Pleasant	A(615)	A(543)	A(613)	A(526)
LT and RT from Tilton	D(101)	E(66)	E(94)	E(59)
Main with Pleasant				
LT from NB Main	A(456)	B(365)	A(448)	B(364)
LT from Pleasant	F(-105)	E(28)	F(-110)	E(11)
RT from Pleasant	A(420)	D(140)	B(419)	D(132)
Cherry with Tilton				
LT from NB Cherry	A(1117)	A(1090)	A(1117)	A(1090)
LT and RT from Tilton	A(947)	A(886)	A(947)	A(886)
Summer with Cherry				
LT from EB Summer	A(850)	A(835)	A(845)	A(835)
LT and RT from SB Cherry	A(665)	A(649)	A(661)	A(649)
THRU and RT from WB Summer	A(425)	B(398)	A(420)	B(396)
Union with Site's South DW				
LT from EB Union	-	-	A(423)	B(355)
LT from Parking Lot	-	-	E(2)	F(-124)

RT from Parking Lot	-	-	A(433)	C(211)
LOS (Reserve Capacity-Vehicles)				

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.8-29 lists the results of this analysis for the A.M. and P.M. peak generator hours.

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS "E" under the "Build" and "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,100 additional vehicles before reaching capacity.

Table 1.8-29 2001 Peak Generator Hour Road Segment Level of Service

Ashland-East	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1151)	E(1281)	E(1178)	E(1251)
Pleasant Street East of Site	D(1269)	D(1415)	D(1288)	D(1394)
Cherry Street at Railroad Grade Crossing	C(1649)	C(1810)	D(1487)	D(1688)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. As seen in the table, the stopping of traffic for train crossings does not have a significant impact on the flow of traffic along Cherry Street.

Year 2001 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.8-30 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. roadway and peak generator hours.

As shown in the table, none of the intersections meet the 10 percent threshold requirements, though the Union Street with the south driveway intersection will round off to ten percent.

As shown in the table none of the road segments meet the 10 percent threshold requirements.

Table 1.8-30 2001 "Build" Conditions - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Pleasant with High	5.0%	5.0%
Pleasant and Site's West Driveway	5.5%	5.3%
Pleasant and Site East Driveway	1.6%	6.4%
Pleasant and Tilton	1.2%	1.5%
Main and Pleasant	0.8%	1.1%
Main and Front	0.3%	0.4%
Main and Summer	0.0%	0.0%
Main and Union	5.9%	6.4%
Cherry with Tilton	0.0%	0.0%
Summer with Cherry	0.3%	0.5%
Union with Summer	7.5%	8.9%
Union with Site's South Driveway	9.9%	9.6%
Roadway Segment		
Cordaville Rd. West of Site	4.3%	5.2%
Pleasant St. East of Site	1.3%	1.6%
Cherry St. at Railroad Crossing	0.0%	0.0%

Site generated traffic as a percentage of total traffic

Summary of Findings

The basic findings of the traffic analysis were that most of the streets and intersections studied in Ashland are currently operating well. The addition of the proposed commuter rail station on Pleasant Street would attract a projected ridership of 837 patrons by the year 2001, while seriously impacting only two of the Town's intersections. These two signalized intersections lie south of the rail tracks on Union Street. The Main Street/Union Street and Union Street/Summer Street intersections would be burdened by the additional traffic during A.M. and P.M. peak hours. It should be noted that even without the proposed commuter rail station in place, these

two intersections are projected to have serious congestion problems due to normal growth, particularly during morning peak hours. Optimization of the signal timings at these intersections may realize an improvement for their level of service ratings. It should also be noted that construction of the commuter rail facility will have a positive impact on other routes throughout Ashland, particularly Route 135, Route 126, Main Street through the center of town, and the Massachusetts Turnpike, by removing a portion of their peak hour traffic.

1.9 Ashland Station-West

Project Introduction

The proposed location for the Ashland Commuter Rail Station is between High Street and the existing Conrail tracks and Megunko Road. There will be two parking lots. One north of the Conrail tracks with access to High Street and one south of the tracks with access to Union Street. It is proposed that the total parking be approximately 700 parking spaces with 200 in the northern parking lot and 500 in the southern parking lot. This arrangement should eliminate the need for traffic to cross the Conrail tracks on Main Street or Cherry Street to access the stations parking lots.

This site is one of two sites selected by both the MBTA and a citizen committee established by the Ashland Board of Selectmen after a review of 8 to 10 potential sites. This location was chosen based on its potential parking capacity, availability of vacant land, proximity to major access roadways, joint development potential and the minimal potential for environmental and neighborhood impacts.

The proposed station will consist of two 800 foot long low level platforms with 45 foot long mini-high platforms for handicapped access, a pedestrian overpass, a drop-off area for Kiss 'n' Ride patrons in each parking lot, adequate lighting for public safety and landscaping.

Study Area

The study area for assessment of traffic impacts at this station is focused on roadways which are anticipated to be used as the major access routes. These roadways include:

- Pleasant Street
- Oak Hill Road (Southborough)
- Oak Street
- Cordaville Road
- Southville Road (Southborough)
- Union Street (Route 135)
- Summer Street
- Cherry Street
- Main Street

Most of these roadways are maintained by the Town of Ashland. Cordaville Road is an unnumbered route maintained by the State. Oak Hill Road and Southville Road are located in Southborough and maintained by the Town of Southborough.

Most of these roadways are two lane facilities with at-grade intersections controlled by stop signs or traffic signals. These roadways serve a mixture of light industrial, commercial, retail and residential land uses. Truck travel is restricted along Myrtle Street between Main Street and the Framingham Town line. Trucks over 2.5 tons are prohibited. A designated truck route exists for access between the town center and Route 9. This route includes Pleasant Street, Cordaville Road, Oak Street and Route 9.

Two at-grade railroad crossings exist which require analysis. The existing railroad tracks cross Cherry Street and Main Street, east of the proposed station site. Currently, Amtrak and Conrail utilize the line. Additional commuter trains destined to and from Boston during peak travel periods will necessitate more frequent stoppages of traffic on both Main Street and Cherry Street.

Data Collection

To assess the existing transportation environment, a data collection program was performed from October to December of 1992. These counts were supplemented by counts made in June of 1994. Data items necessary for analysis of operational levels of service include: peak hour traffic volumes, intersection turning movements, vehicle classifications, traffic signal phasing and timing, and geometric configuration of roadway links and intersections.

Intersection turning movement counts were performed at the following intersections:

- Pleasant Street with Main Street
- Pleasant Street with Tilton Avenue
- Pleasant Street with High Street
- Main Street with Front Street
- Main Street with Summer Street and Homer Avenue
- Cherry Street with Tilton Avenue
- Cherry Street with Summer Street
- Union Street with Main Street
- Union Street with Summer Street

Vehicle turning movements at these intersections were observed and recorded from 6:30 to 9:00 A.M. and from 4:00 to 7:00 P.M. These observation periods were selected to ensure recording of the roadway peak hour volumes, and the volumes during the projected commuter rail station peak generator hours.
The turning movement counts used to obtain the traffic volumes used in the existing conditions level of service analysis were made at the following intersections on the following dates:

	A.M.	P.M.
Pleasant with High	6-23-94	6-23-94
Pleasant with Tilton	11-12-92	11-10-92
Pleasant with Main	11-10-92	10-20-92
Cherry with Tilton	12-2-92	12-1-92
Main with Front	10-8-92	10-1-92
Main with Summer and Homer	12-8-92	12-2-92
Cherry with Summer	12-1-92	11-24-92
Union with Summer	6-8-94	6-8-94
Union with Main	6-14-94	6-14-94

Vehicles were classified into two categories: cars, and trucks or buses. Volumes were recorded in 15 minute intervals to allow determination of the peak hour, and calculation of peak hour factors. The 1992 peak hour traffic volumes are shown on Figures 1.9-1 and 1.9-2 for the A.M. and P.M. peak hours respectively. Since peak generation hours for the station's traffic may not coincide with standard peak hours, it is also necessary to analyze the A.M. and P.M. peak generator hours. The 1992 site peak generator hours are shown on Figures 1.9-3 and 1.9-4 for the A.M. and P.M. peak hours respectively.

Traffic signal timing is required for analysis of signalized intersection operations. The existing traffic signals within the study area are traffic actuated. Phasing and timing of actuated signals were obtained from the Town of Ashland Highway Department.

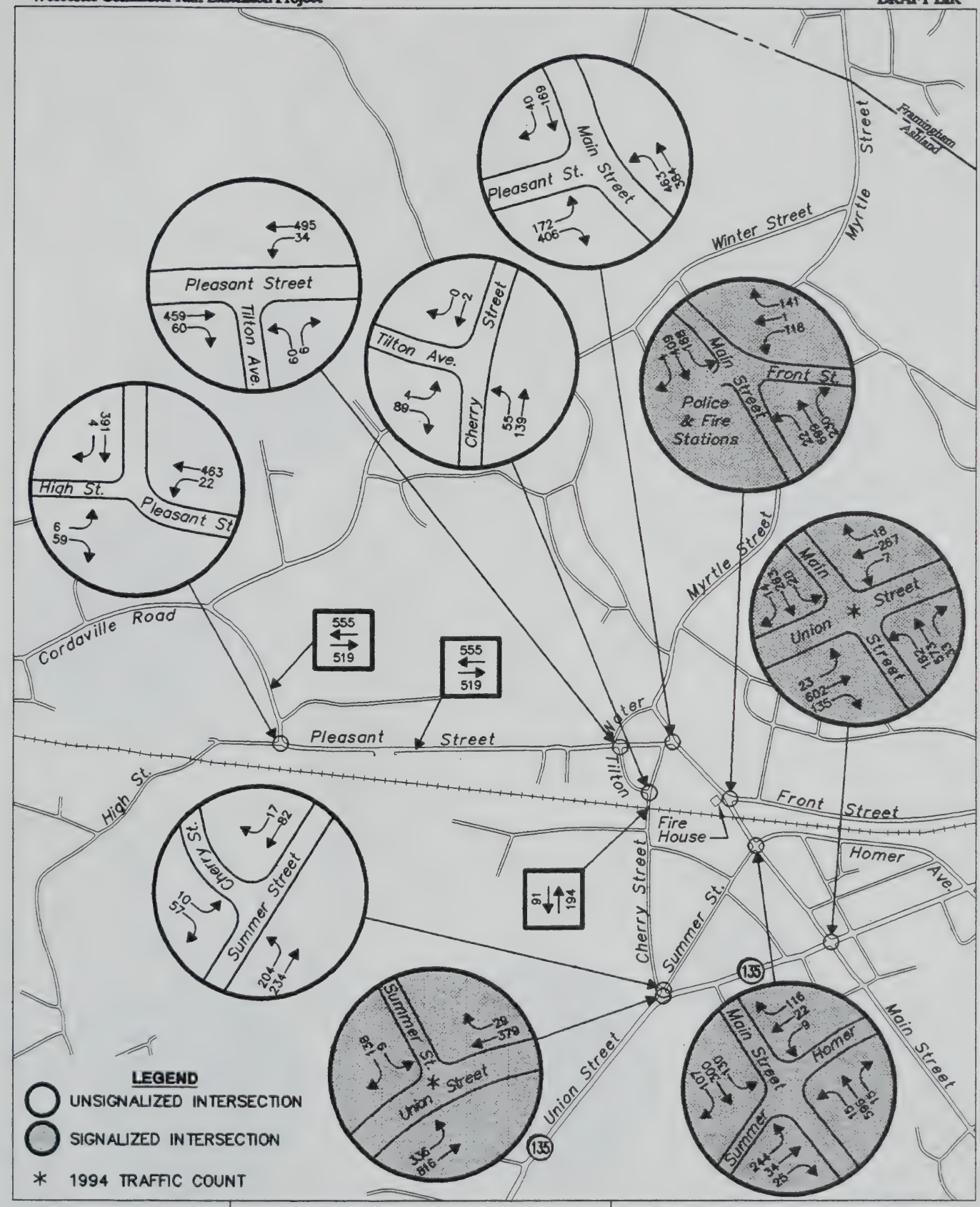
Intersection geometric configurations were determined through field observations. Geometric elements such as number and use of travel lanes, lane widths, and roadway grades are required for analysis of operational conditions and were observed in the field.

The field data sheets for the counts are included in an uncirculated appendix available for review at the MBTA and MEPA Office.

Year 1992 Existing Conditions

Signalized Intersections

The existing signalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209*, (HCM). The micro-computer software package "CINCH", developed by Central Transportation Planning Staff (CTPS) was used for the intersection analysis. The computerized outputs of "CINCH" can be found in an uncirculated report

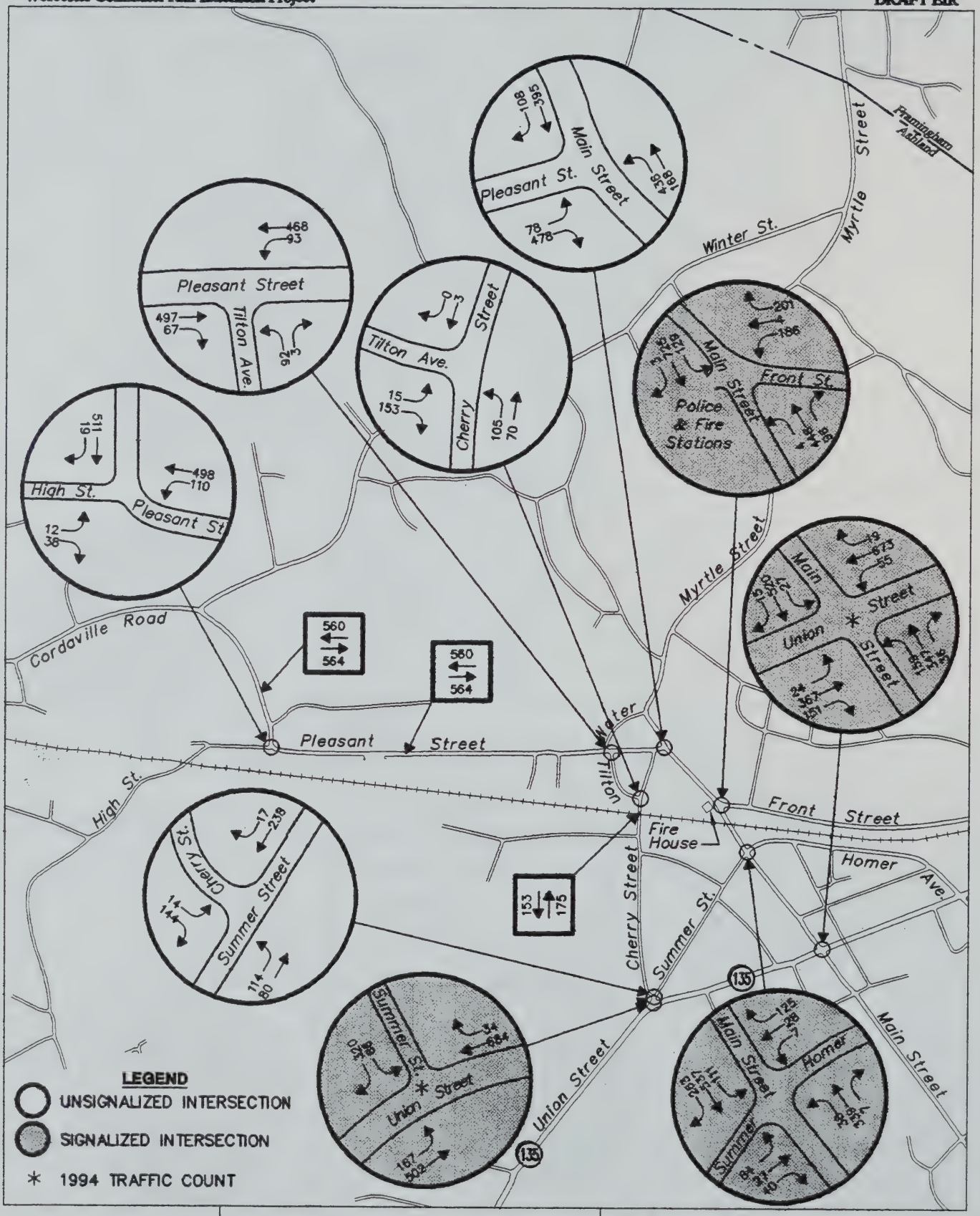


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1992 Existing Conditions
ASHLAND STATION-WEST

FIGURE 1.9-1

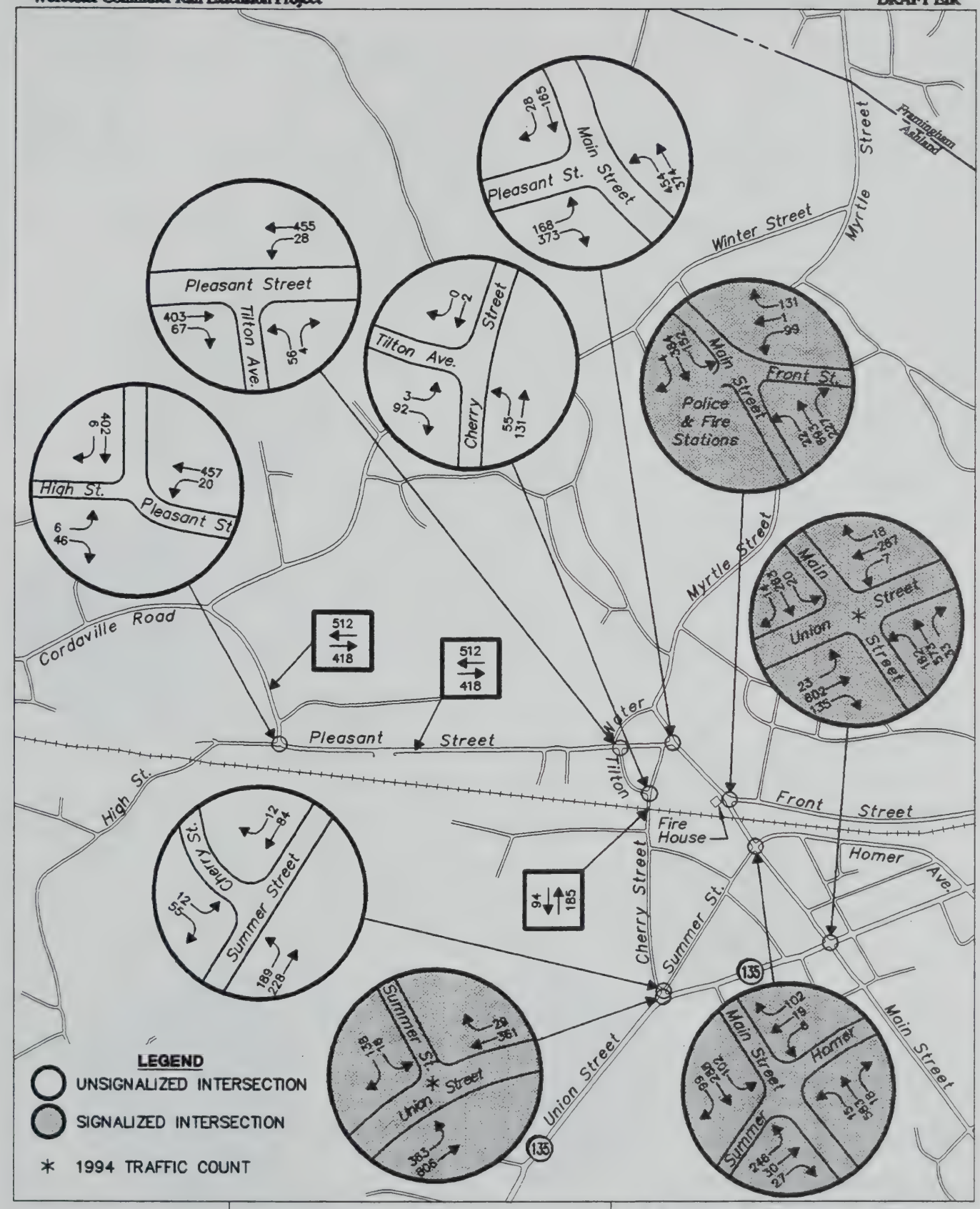


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1992 Existing Conditions
ASHLAND STATION-WEST

FIGURE 1.9-2



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
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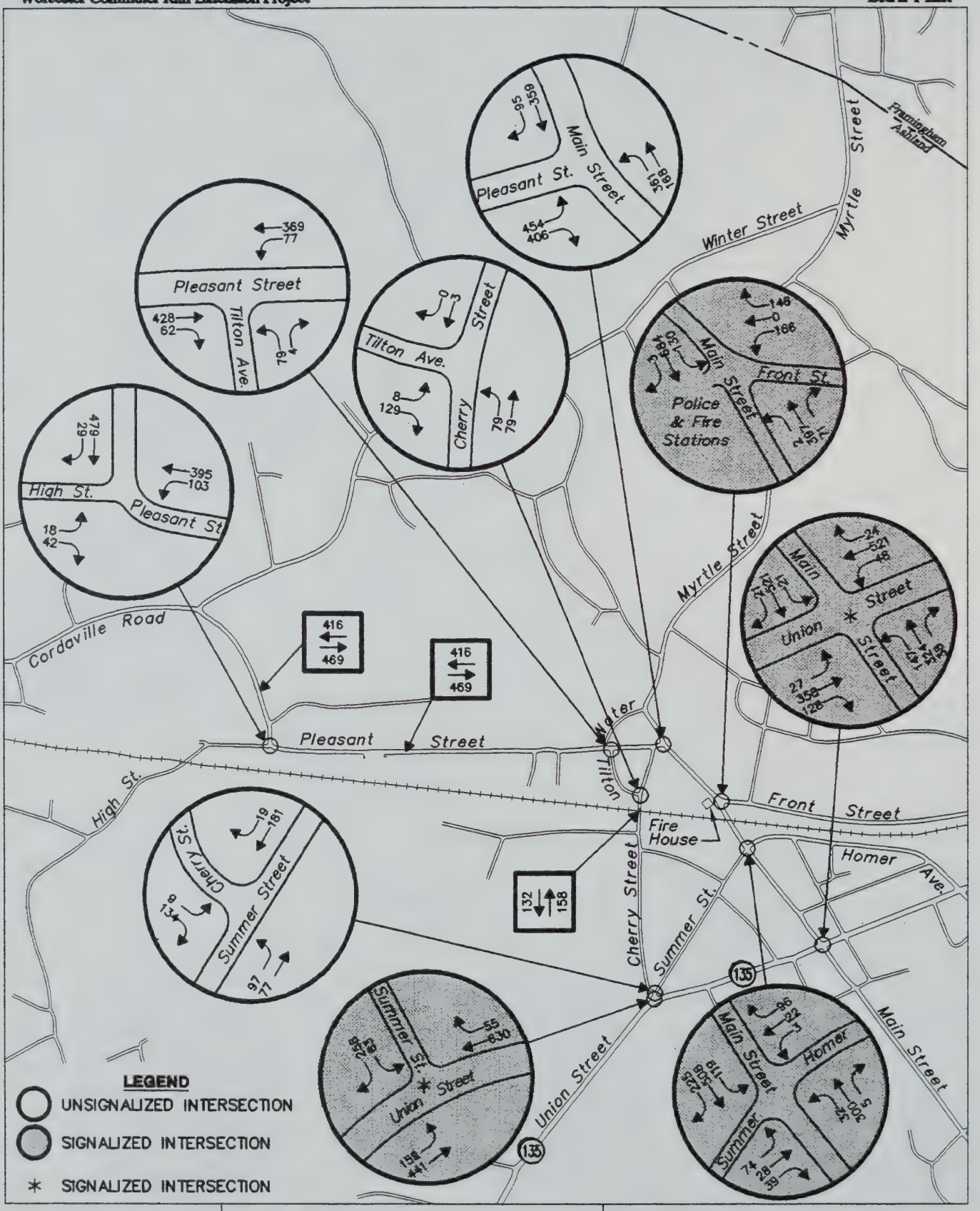
A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1992 Existing Conditions
ASHLAND STATION-WEST

FIGURE 1.9-3



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1992 Existing Conditions
ASHLAND STATION-WEST

FIGURE 1.9-4

available at the MBTA and MEPA. This program automates the analysis procedures of the HCM.

The analysis is based on various parameters such as intersection geometrics, traffic volumes and movements, traffic signal timing, vehicle mix, etc. The average length of time that a vehicle is sitting stationary at the intersection, known as average vehicle stopped delay, is determined and used to categorize the level of service (LOS) of the intersection. LOS ranges from a virtual free flowing condition "A", to congestion and high stopped delays "F". A detailed description of level of service is presented in Section 1.1 of this report.

The approach capacities were decreased for most approaches for the intersections of Main Street with Front Street and Main Street with Summer Street and Homer Avenue to account for the effects of the at-grade railroad crossing adjacent to these intersections. The periodic gate closings effectively reduce intersection capacity proportional to the length of the closing. Roadway operations at the grade crossing are controlled by the level of service at the two adjacent signalized intersections. A complete explanation of the methodology used to adjust intersection capacity at railroad grade crossings is provided in Section 1.1 of this Appendix. Four signalized intersections were analyzed and include the following:

Main Street/Front Street Intersection

The intersection of Front Street with Main Street is a "T" intersection located in the Commercial-B district in Ashland center just north of the railway grade crossing on Main Street. The intersection is controlled by a traffic actuated signal. The entrance driveway to the police and fire stations is located opposite Front Street. This intersection, along with the Main Street/Summer Street and Homer Avenue intersection, was chosen to analyze the impacts to Main Street due to the additional railroad gate closings. Front Street is an east-west two lane, two way collector roadway. Main Street is a north-south two lane, two way arterial roadway.

Main Street/Summer Street and Homer Avenue Intersection

This cross road intersection is located just south of the railway grade crossing at Main Street in the Commercial-B district of Ashland center. It is controlled by a traffic actuated signal. Summer Street and Homer Avenue are two lane, two way collector roads. Main Street is a two lane, two way arterial roadway.

Main Street/Union Street Intersection

This cross road intersection is located south of the Main Street/Summer Street and Homer Avenue Intersection in the Commercial-B district of Ashland Center. It is

controlled by a traffic actuated signal. Main Street is a two lane, two way arterial roadway. Union Street is a two lane, two way undivided state highway (Route 135).

Union Street/Summer Street Intersection

This "T" intersection is located west of the Main Street/Union Street intersection in the Commercial-B district of Ashland Center. It is controlled by a traffic actuated signal. Union Street is a two lane, two way undivided state highway (Route 135). Summer Street is a two lane, two way collector road connecting Union Street and Main Street.

Table 1.9-1 lists the results of the signalized intersection analysis for the A.M. and P.M. peak traffic hours. The peak generator hour for the commuter rail station is also shown and is the hour that usage of the rail station will be heaviest. The table shows the overall LOS rating for the intersection as well as each movement, and the average vehicle stopped delay, in seconds. Signalized intersections may be assigned an overall LOS rating as well as a LOS rating for the individual approaches. As shown in the table, the Main Street/Front Street and Main Street/Summer Street intersections operate at acceptable overall levels of service during both the A.M. and P.M. peak hours. During the A.M. peak hour the northbound approach to Main Street at Front Street, and the southbound approach to Main Street at Summer Street operate at LOS "E", while the eastbound approach to Summer Street at Main Street operates at an unacceptable LOS "F". During the P.M. peak hour, the southbound approach of Main Street at Front Street operates at low LOS "E".

The Main Street/Union Street intersection is at LOS "E" in the A.M. peak hour while the Union Street/Summer Street intersection operates at unacceptable LOS "F" in both the A.M. and P.M. peak hours. The eastbound approach to the Main Street/Union Street intersection is at LOS "F" in the A.M. peak hour and in the P.M. peak hour the westbound approach is at LOS "E". At the Union Street/Summer Street intersection, the eastbound and westbound approaches are LOS "F" in the A.M. peak hour while the westbound and southbound approaches function at LOS "F" in the P.M. peak hour.

Table 1.9-1 1992 Existing Signalized Intersection Level of Service

Ashland-West	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Main and Front	D(29.1)	D(33.3)	D(30.0)	C(24.0)
Westbound	C(23.2)	D(25.2)	C(22.8)	D(25.2)
Northbound	E(43.2)	C(15.6)	E(44.0)	B(13.8)
Southbound	B(8.9)	E(46.6)	B(8.1)	D(29.2)
Main and Summer	D(34.5)	B(13.5)	D(30.1)	B(14.8)
Eastbound	F(61.9)	C(18.9)	F(77.1)	C(18.3)
Westbound	C(17.1)	C(17.0)	C(16.6)	C(16.6)
Northbound	B(12.6)	B(7.8)	B(12.7)	B(7.4)
Southbound	E(49.7)	B(14.4)	D(26.8)	C(16.9)
Main with Union	E(45.2)	D(26.8)	E(45.2)	C(18.7)
Eastbound	F(106)	C(17.1)	F(106)	C(16.1)
Westbound	B(7.9)	E(54.4)	B(7.9)	D(31.1)
Northbound	C(15.2)	B(11.7)	C(15.2)	B(9.9)
Southbound	B(7.2)	C(15.5)	B(7.2)	B(14.2)
Union with Summer	F*	F*	F*	F*
Eastbound	F*	B(13.5)	F*	B(12.9)
Westbound	F(63.3)	F*	F(60.4)	F*
Southbound	B(14.2)	F(61.5)	B(14.2)	E(40.3)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

The results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.9-1. As shown, the Main Street/Front Street intersection, the Main Street/Summer Street intersection and the Main Street/Union Street intersection all have acceptable overall levels of service in the peak generator hours. The northbound Main Street approach at Front Street is at LOS "E" in the A.M. generator hour. The eastbound Summer Street approach to Main Street and the eastbound Union Street approach to Main Street are at LOS "F" in the A.M. generator hour. The Union Street/Summer Street intersection is at LOS "F" during both peak generator hours. The eastbound approach operates at LOS "F" in the A.M. generator hour while

the westbound approach operates at LOS "F" in both the A.M. and P.M. generator hours.

Unsignalized Intersections

The existing unsignalized intersections were analyzed using the methodology set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209, (HCM)*. The software program "CINCH" was used to perform the analysis. The computerized outputs of "CINCH" can be found in an uncirculated report available at the MBTA and MEPA. As with the signalized intersections, A.M. and P.M. analysis was performed for both the intersection peak hour and the site peak generator hour.

As opposed to the signalized intersection results, levels of service for unsignalized intersections are stated in terms of reserve capacity for a particular movement only. Reserve capacity is as the name implies: the total capacity of a particular traffic movement minus the volume of traffic making that movement. A detailed description of level of service is provided in Section 1.1 of this report.

Five unsignalized intersections were analyzed and include the following:

Cherry Street/Tilton Avenue Intersection

The intersection of Cherry Street and Tilton Avenue is a "T" intersection located north of the at-grade railroad crossing on Cherry Street and bordered by Residential-B, Industrial, and Commercial-B districts. Cherry Street is a north-south subcollector carrying traffic in two lanes between Summer Street and Tilton Avenue. At Tilton Avenue Cherry Street becomes one way northbound to Pleasant Street. Tilton Avenue is a two way, two lane subcollector connecting Pleasant Street with Cherry Street. There is no stop sign at this intersection. However, it was observed that drivers generally behave as if Tilton Avenue was stop controlled. Therefore, the intersection was analyzed with stop control on Tilton Avenue.

Pleasant Street/Tilton Avenue Intersection

The intersection of Tilton Avenue with Pleasant Street is also a "T" intersection, located north-west of Ashland center and bordered by Residential-B and Industrial Districts. Pleasant Street is an east-west two lane, two way collector. Tilton Avenue is controlled by a stop sign at it's intersection with Pleasant Street.

Main Street/Pleasant Street Intersection

The intersection of Pleasant Street with Main Street is a "T" intersection located north of Ashland center and bordered by Residential-B, Industrial, and Commercial-B districts. Main Street is a north-south collector roadway. The eastbound Pleasant Street approach has an exclusive right turn lane and an exclusive left turn lane. The Pleasant Street approach is stop controlled.

Cherry Street/Summer Street Intersection

The intersection of Cherry Street with Summer Street is a "T" intersection located south of Ashland Center and just north of Route 135, in a mixed use district. Cherry Street is a two lane, two way subcollector. Traffic control is unusual in that there are two stop signs controlling two different legs at this intersection. Vehicles travelling south on Cherry Street are stopped before turning left or right onto Summer Street. Vehicles travelling west on Summer Street are stopped before the intersection with Cherry. Vehicles travelling east on Summer have a through movement. Analysis procedures were slightly modified to account for this configuration. The movements at this intersection were analyzed in two steps. The first assumed a stop sign to exist only for the Cherry Street southbound leg. This yielded a LOS rating for both movements on Cherry Street and the left turn from Summer onto Cherry. The second analysis assumed a stop sign on Summer Street only. This yielded a LOS rating for the southbound Summer Street movements.

Pleasant Street/High Street Intersection

The intersection of Pleasant Street with High Street is a "T" intersection located north-west of Ashland Center and west of the proposed station in an Industrial and Commercial-B district. Pleasant Street is a two lane, two way collector road. High Street is a two lane, two way subcollector road with stop control at Pleasant Street.

Results of the A.M. and P.M. peak hour analyses for the unsignalized intersections are listed in Table 1.9-2. The table shows the LOS rating as well as the reserve capacity, in vehicles, for each intersection movement. Unlike signalized intersections, only individual movements are assigned a level of service rating. The intersection cannot be assigned an overall rating. As shown in the table, most of the analyzed intersection movements operate at acceptable levels of service. During the A.M. roadway peak hour, the eastbound left turn movement from Pleasant Street onto Main Street operates at a LOS "F". During the P.M. roadway peak hour, the northbound left and right turn movements from Tilton Avenue to Pleasant Street and the eastbound left turn from Pleasant Street to Main Street operate at a LOS "E".

Table 1.9-2 1992 Existing Unsignalized Intersection Level of Service

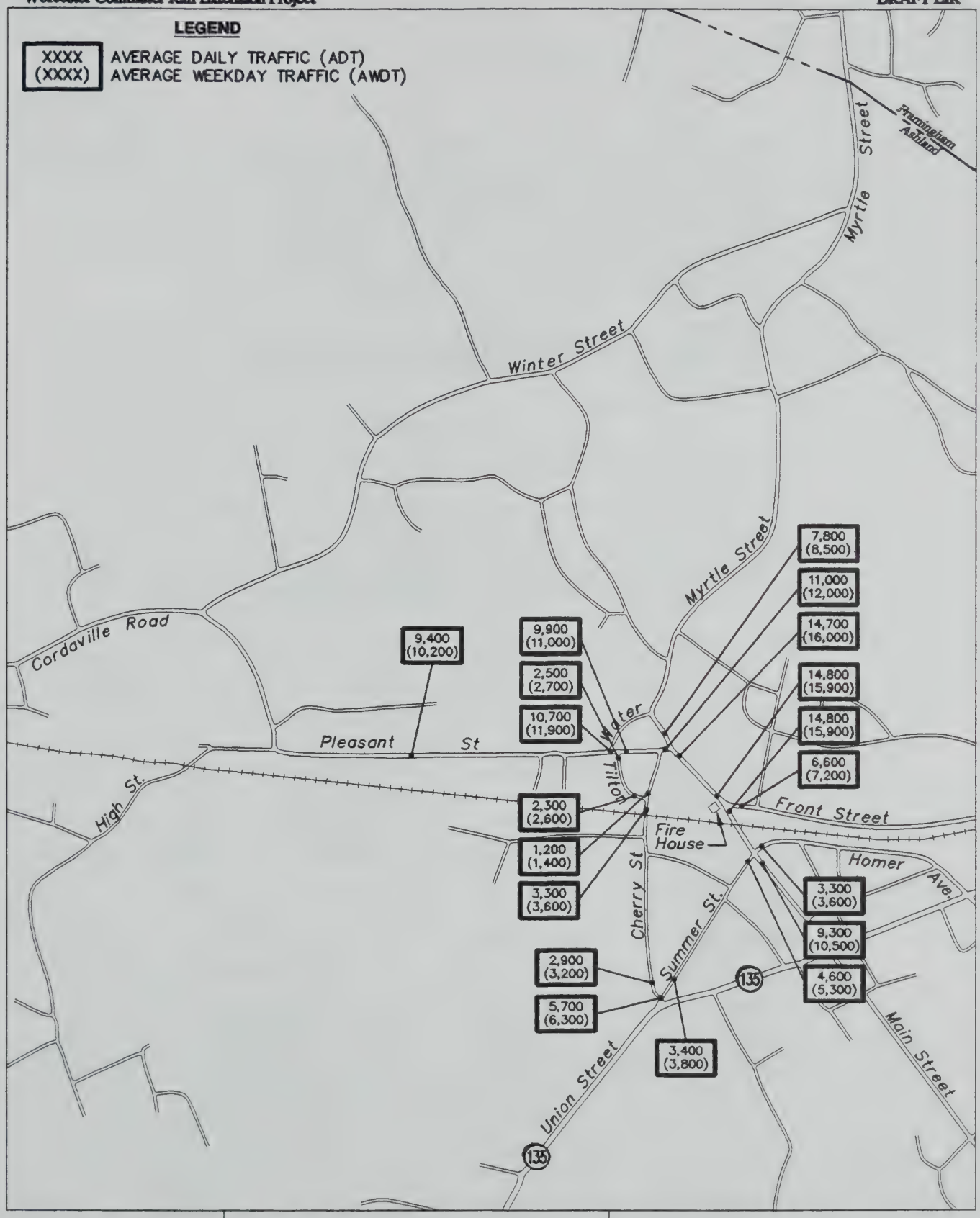
Ashland-West	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(639)	A(446)	A(630)	A(468)
LT and RT from High	B(346)	D(154)	B(336)	D(164)
Pleasant with Tilton				
LT from WB Pleasant	A(609)	A(517)	A(653)	A(589)
LT from Pleasant	D(102)	E(34)	D(137)	D(106)
Main with Pleasant				
LT from NB Main	A(505)	B(320)	A(158)	A(431)
LT from Pleasant	F(-72)	E(4)	F(-62)	E(64)
RT from Pleasant	A(440)	D(161)	A(474)	C(215)
Cherry with Tilton				
LT from NB Cherry	A(1122)	A(1072)	A(1122)	A(1098)
LT and RT from Tilton	A(951)	A(851)	A(956)	A(903)
Summer with Cherry				
LT from EB Summer	A(861)	A(792)	A(880)	A(864)
LT and RT from SB Cherry	A(717)	A(598)	A(702)	A(686)
THRU and RT from SB Summer	A(456)	B(352)	A(465)	A(444)

LOS (Reserve Capacity-Vehicles)

Results of the A.M. and P.M. peak generator hour analysis are also listed in Table 1.9-2. As shown in the Table, all of the unsignalized intersections operate at acceptable levels of service with the exception of the eastbound left turn movement from Pleasant Street onto Main Street which operates at a LOS "F" during the A.M. peak generator hour.

Roadway Segments

The average daily traffic (ADT) and average weekday traffic (AWDT) was collected for several streets in the downtown area of Ashland. Figure 1.9-5 presents the 1992 ADT and AWDT volumes for several streets showing the relative 24 hour volumes of traffic that use these streets. Several roadway segments were analyzed for level of service. These segments were analyzed using the procedures set forth in the *1985 Highway Capacity Manual, Transportation Research Board, Special Report 209,*



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

1992 Average Daily Traffic & 1992 Average Weekday Traffic ASHLAND, MA

FIGURE 1.9-5

(HCM). The software program "Highway Capacity Software" (HCS) was used to perform the analysis. The computerized outputs from HCS can be found in an uncirculated report available at the MBTA and MEPA. As with the intersection analysis, both the A.M. and P.M. roadway and site peak generator hours were analyzed. Table 1.9-3 lists the results of this analysis for the A.M. and P.M. peak roadway hours, and the A.M. and P.M. peak generator hours.

Table 1.9-3 1992 Existing Road Segment Level of Service

Ashland-West	Peak Hour		Peak Generator Hour	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1174)	E(1183)	E(1229)	D(1366)
Pleasant Street East of Site	D(1307)	D(1319)	D(1360)	D(1500)
Cherry Street at Railroad Grade Crossing	C(1720)	C(1735)	C(1690)	C(1915)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table, of the roadway segments operate at acceptable levels of service. Even though Cordaville Road west of the proposed station location is shown to operate at a LOS "E", there is still sufficient reserve capacity to accommodate over 1,100 additional peak hour vehicles before reaching capacity.

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. Closing of the gates due to train crossings reduces the capacity of the roadway proportional to the length of time the traffic is stopped. As shown, the additional gate closings will not significantly impact level of service on Cherry Street.

Safety Concerns and Accident History

The Ashland Police Department was contacted on July 28, 1994, to determine the existence and location of any safety concerns or high accident history intersections. According to Lt. John Doveno, two locations are considered to be possible high frequency accident locations, both involving railroad grade crossings. These are the grade crossing at Main Street and the grade crossing at Cherry Street. Concern was also expressed about the possibility of increased traffic on the High Street and Fountain Street bridges due to additional drivers using these roads as alternate routes to avoid delays on Main Street in the center of town and the implications for emergency vehicles using these roads.

Year 1996 Conditions

To determine the impacts directly attributable to the proposed rail station, 1996 conditions with and without the railroad service in place were developed and analyzed. These are referred to as the "Build" and "No Build" conditions, respectively. Several assumptions were made in the development of these scenarios. It was assumed that no significant changes would occur to the study area roadway network. All roadways currently open for travel would remain open. No significant improvements to existing roadways, nor construction of new roadways are planned.

Year 1996 "No Build" Traffic Volumes

The "No Build" traffic volumes are typically projected based upon two elements:

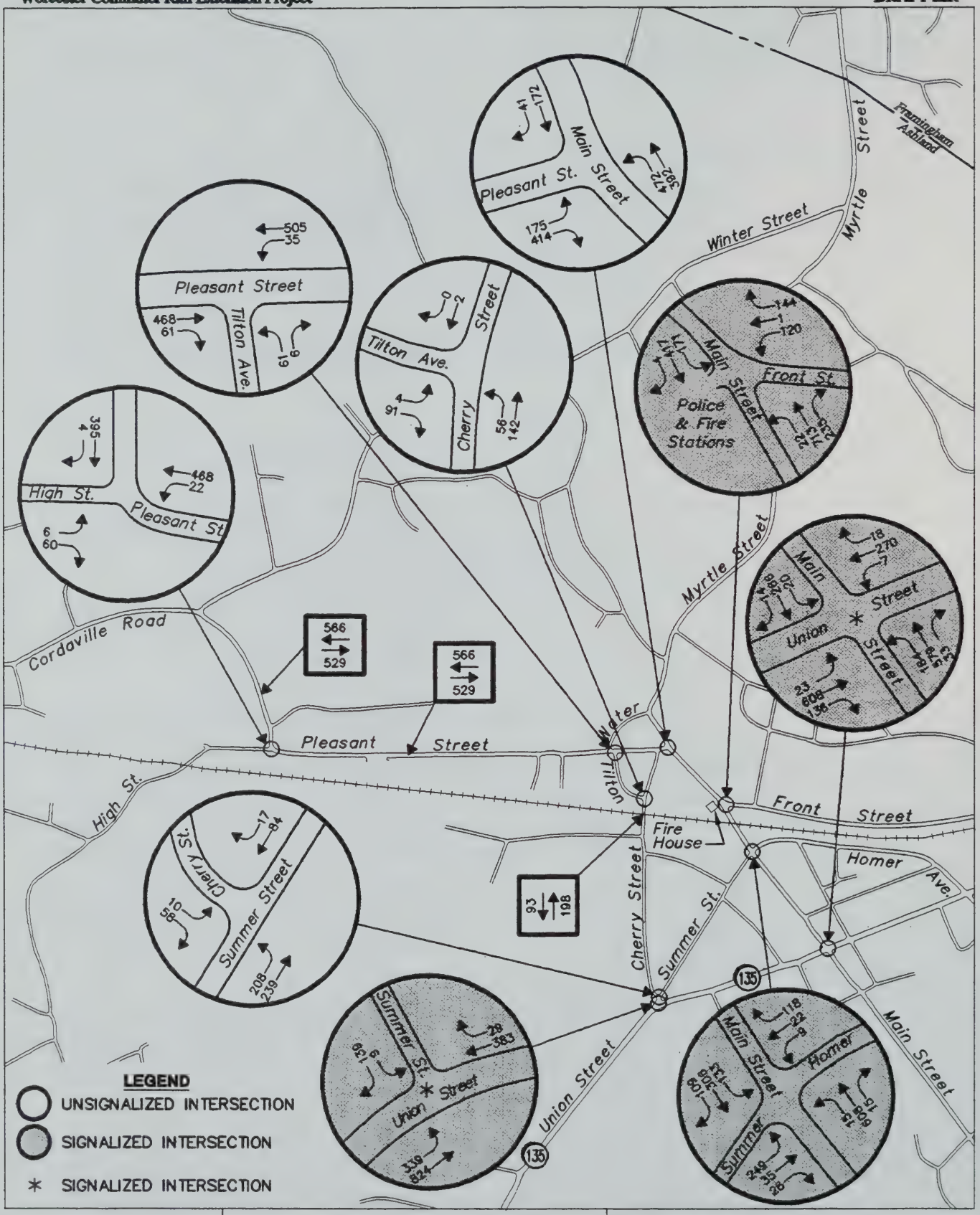
- Traffic volumes generated by planned developments within the study area.
- Increases in existing traffic volumes due to population growth and development proximate to, but outside of the study area.

Through discussions with the Town of Ashland, it was determined that no major new developments are planned within the study area by 1996. Therefore, this element does not affect the estimation of 1996 "No Build" condition traffic.

Historical traffic data was reviewed to determine the annual rate of growth in traffic volumes within the study area. The Massachusetts Highway Department compiles and publishes traffic volume data through a statewide traffic counting program. Five count sites from this data source are located within the immediate vicinity of the study area in Ashland. Based upon the data from these five sites, the traffic volume growth rate was found to be extremely low. Two of the locations experienced a growth rate of negative 2.5 percent. Two other locations experienced a growth rate of positive 2.5 percent and one location experienced a growth of 0.2 percent. A location along Route 9 east of 495 showed an average rate of negative 2.5 percent over the last 6 years.

This relatively low growth rate may be due to the economic downturn experienced throughout the region over the past years. Economic indicators point towards a recovery, leading to lower unemployment, increased economic vitality, and hence higher growth in traffic volumes.

To account for this potential growth, and to yield a more conservative analysis, a background traffic growth rate of 0.5 percent per year was applied to the 1992 existing condition traffic volumes. Figure 1.9-6 shows the projected A.M. peak hour traffic volumes. Figure 1.9-7 shows the projected P.M. peak hour traffic volumes.



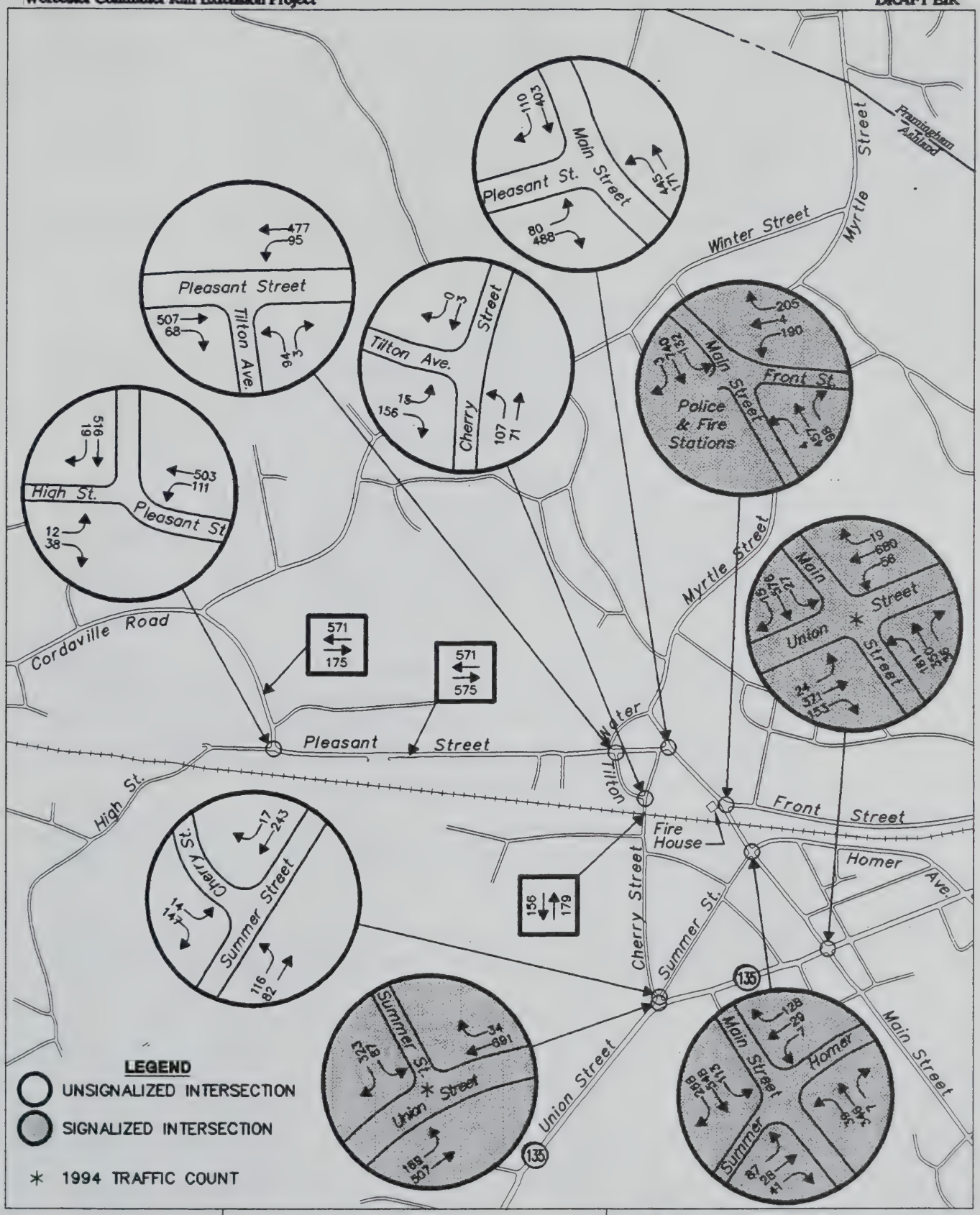
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-6



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-7

Figure 1.9-8 shows the A.M. peak generator hour traffic volumes. Figure 1.9-9 shows the P.M. peak generator hour traffic volumes.

The "No Build" volumes assume that there will be neither a station constructed nor an extension of the commuter rail service to Worcester.

Year 1996 Trip Generation/Parking

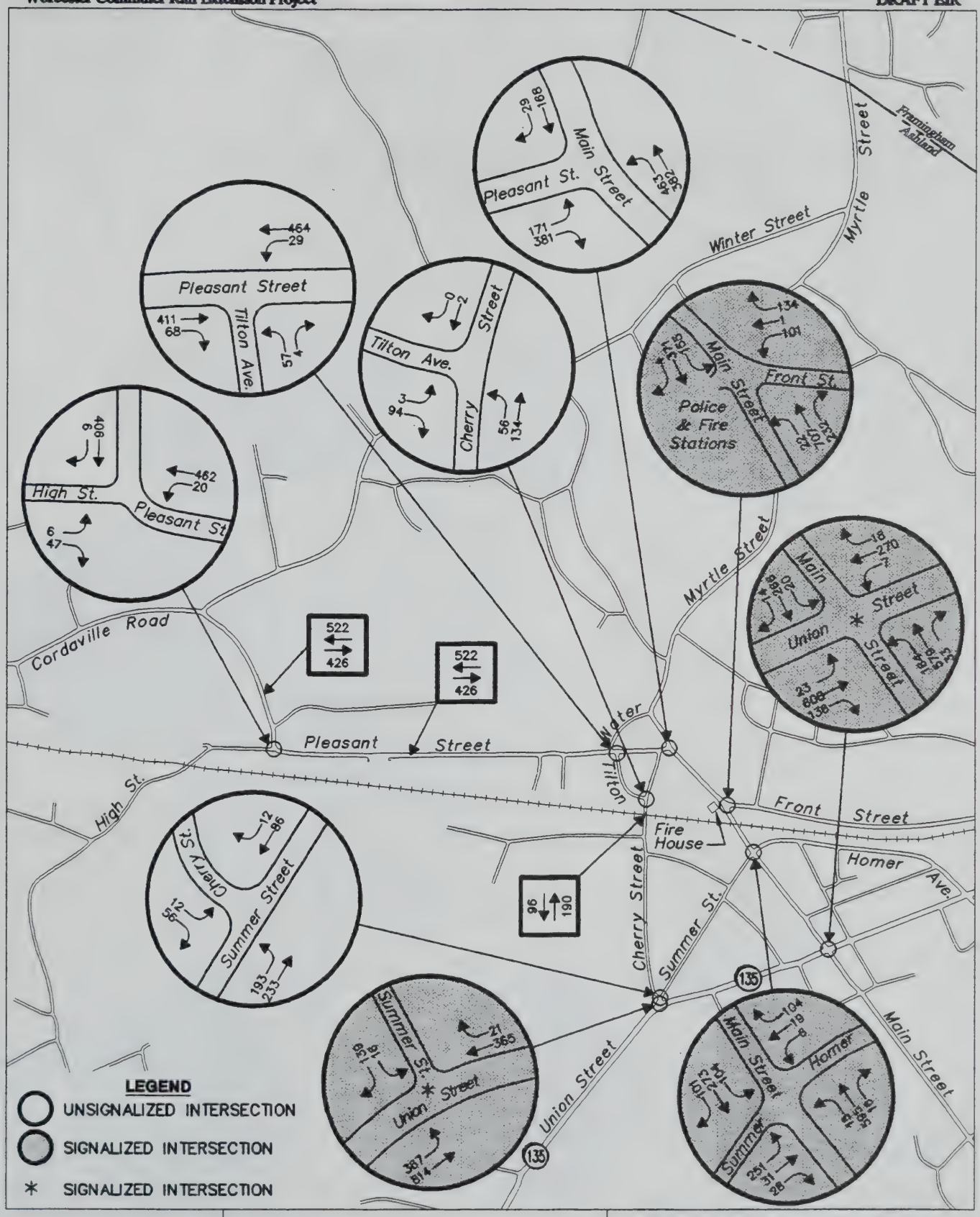
In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension. The CTPS projected that by the year 2011, a total of 2,701 persons are expected to utilize the railroad for daily round trip commutation into Boston.

In 1996, the proposed Ashland Station is projected to attract a total of 738 daily round trip commuters. Twenty of these patrons would walk to the station, while an additional 57 patrons would be dropped off. Based upon an average automobile occupancy rate of 1.12, the remaining 661 Park'n'Ride patrons would result in a parking demand of 590 spaces. This is less than the capacity of the proposed parking lot.

The patrons who will use the Ashland Station are projected to reside in the Towns of Ashland, Holliston, Hopkinton, Marlborough, and Southborough. Based on the proposed station location, all 20 of the patrons who walk to the station will reside in the Town of Ashland. The number of patrons who originate from each Town during the peak commuting periods are shown in Table 1.9-4.

Six percent of the total ridership is expected to occur outside of the peak A.M. and P.M. commuting periods, thus the 738 daily ridership was reduced to 693 riders during the peak commuting hours.

These ridership levels are expected to occur shortly after completion of the Ashland Station, therefore, these projections were used in the analysis of the 1996 "Build" conditions.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
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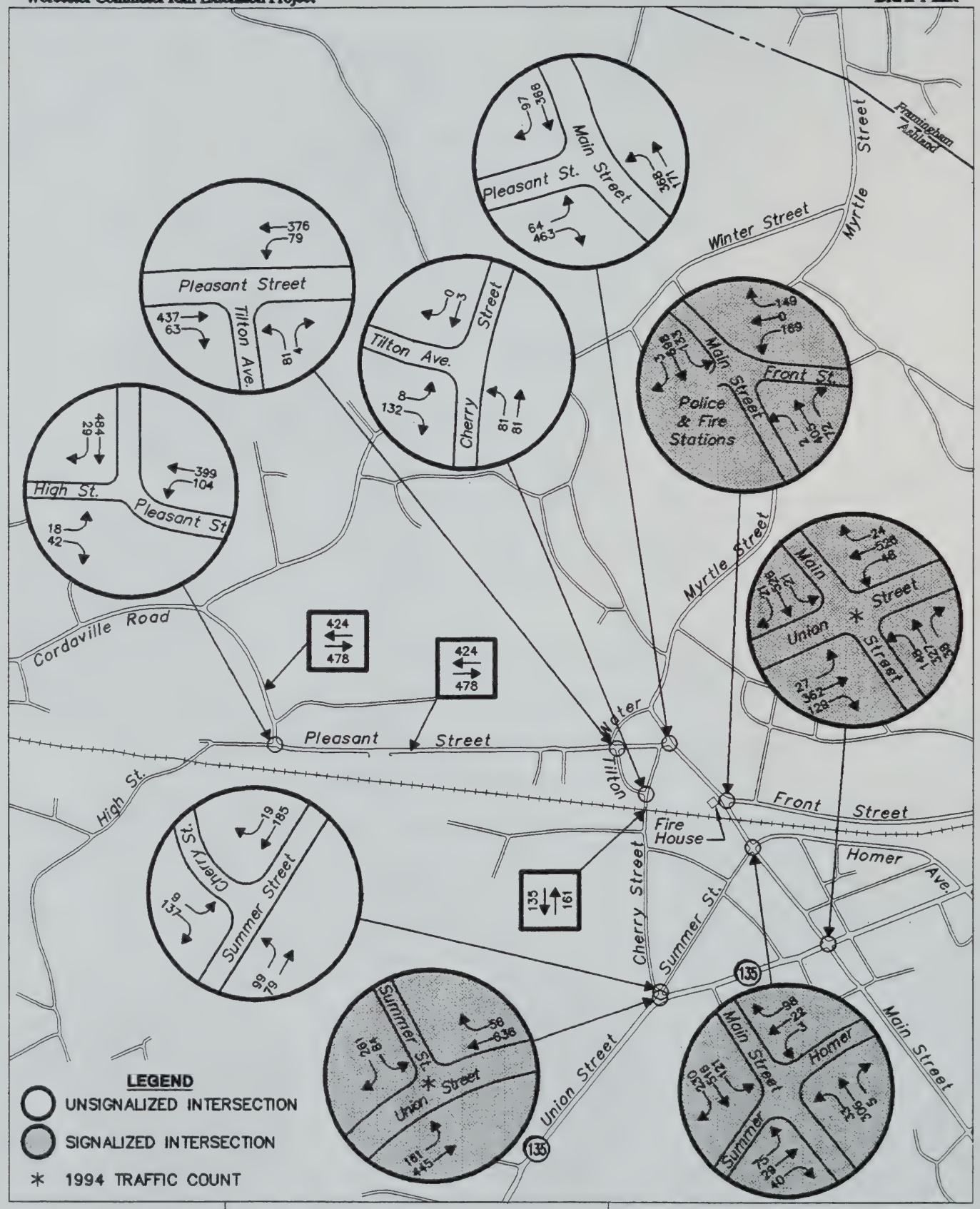
A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1996 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-8



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Generator Hour
7:30 - 8:30 A.M.
1996 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-9

Table 1.9-4 Projected Patrons of Ashland Station - Year 1996	
Town	**Riders***
Ashland	354**
Holliston	262
Hopkinton	44
Marlborough	10
Southborough	23
Total	**693**

* *Adjusted for peak period demand*
** *Includes 20 walk trips from Ashland*

Year 1996 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.9-5 lists the projected distribution of ridership based on arrival/departure time in Boston.

Table 1.9-5 MBTA Ridership Distribution

Inbound Train	Patrons
502A	136
504A	225
506A	225
510	107
Total	**693**
Outbound Train	**Patrons**
515A	97
519A	161
521	160
521A	240
523	35
Total	**693**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 - 9:00 A.M. and 4:00 - 6:00 P.M. Thus, there becomes a need to analyze two peak hours: the roadway peak hour and the commuter rail stations peak generator hour.

The Peak Generator Hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Ashland Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 2 to 4 minutes on average.

In Ashland the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak generator hours for the commuter rail station will be from 7:15 to 8:15 A.M. and from 5:30 to 6:30 P.M.

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Ashland would utilize a variety of travel routes, depending on the location of their residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station.

Patrons from Marlborough and Southborough would access the station's northern parking lot via Cordaville Road. Patrons from Holliston would access the station's southern parking lot via Main Street and Route 135. Patrons from Hopkinton will access the stations southern parking lot via Route 135. Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.9-10 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

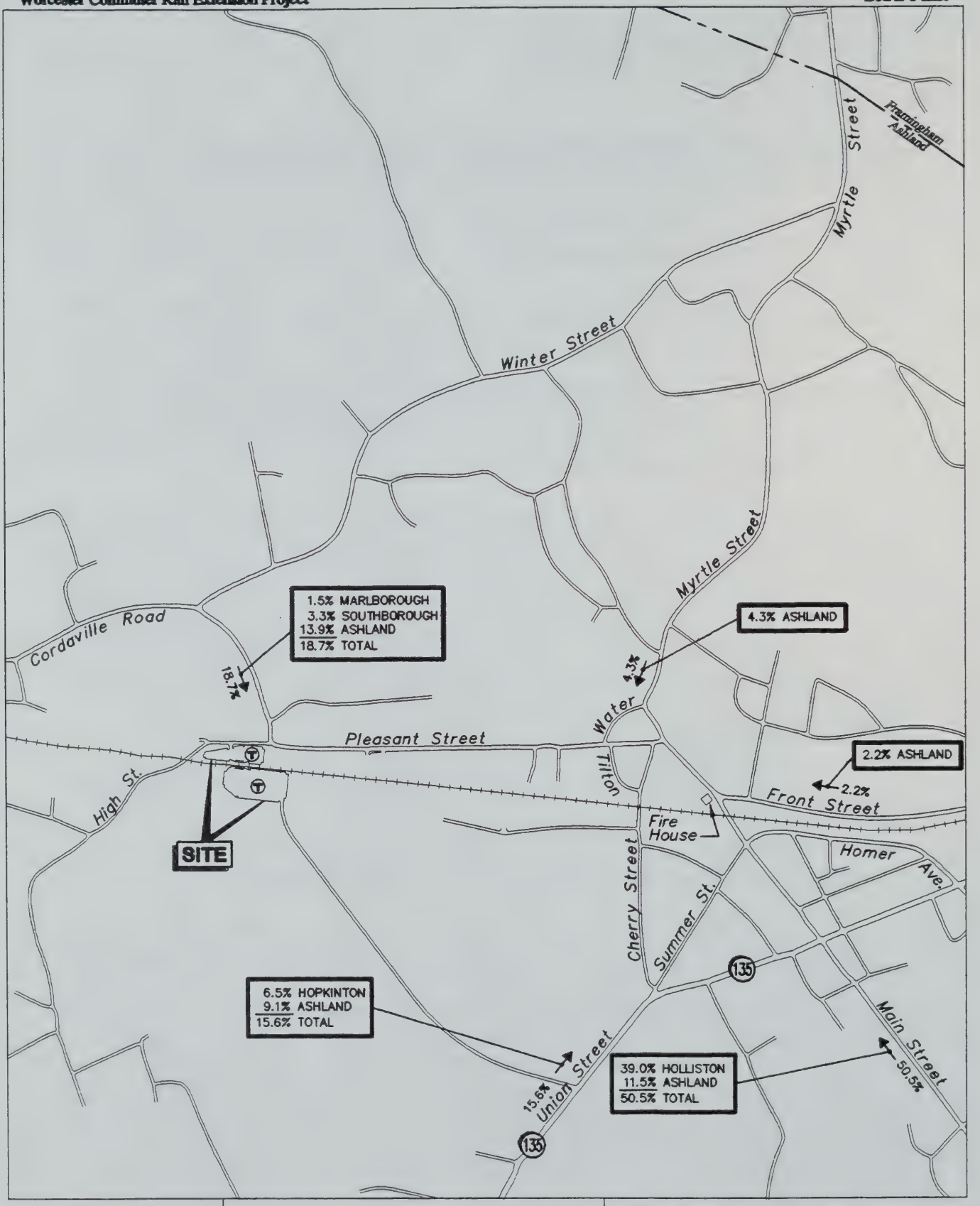
Upon completion of the commuter rail service, commuters will shift form automobile usage to rail usage. Approximately the same number of vehicle trips will be made in the Study area, but the trips to the rail station will be along alternate roadways and be of a shorter duration. Traffic volumes are expected to decrease along most portions of Routes 135 and 126, Route 9 and the Mass Pike. Traffic volumes are expected to increase on sections of Cordaville Road, Main Street, Pleasant Street, and Union Street near the commuter rail station.

Year 1996 "Build" Traffic Volumes

Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Ashland rail station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Ashland Center, which includes Pleasant Street, Union Street, and Main Street. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways including Pleasant Street. This results in a "worst case" analysis. Figures 1.9-11 and 1.9-12 show the A.M. and P.M. peak hour traffic volumes respectively. Figures 1.9-13 and 1.9-14 show the A.M. and P.M. peak generator hour traffic volumes.



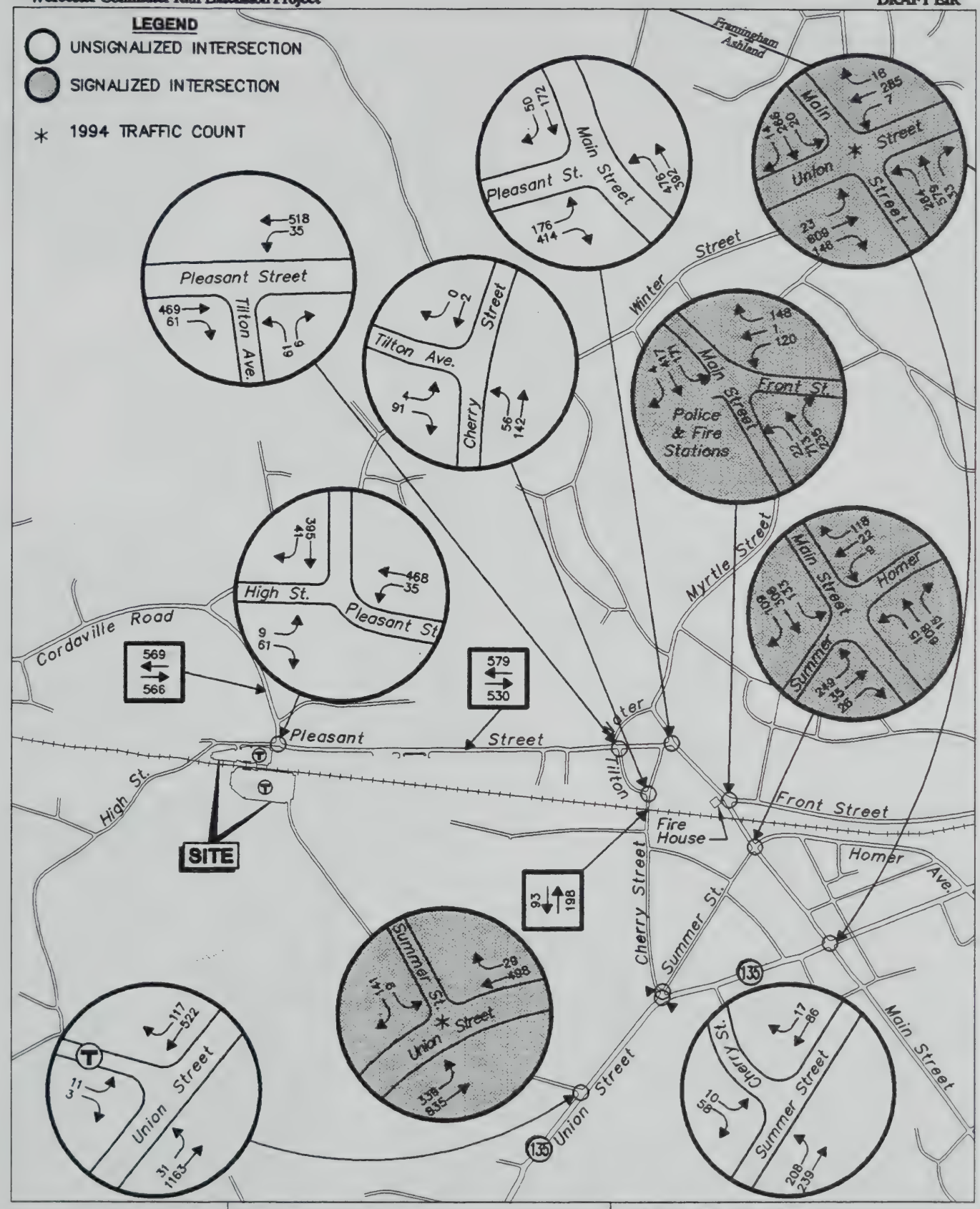
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

Distribution of Commuter Rail Station Traffic
1996 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-10

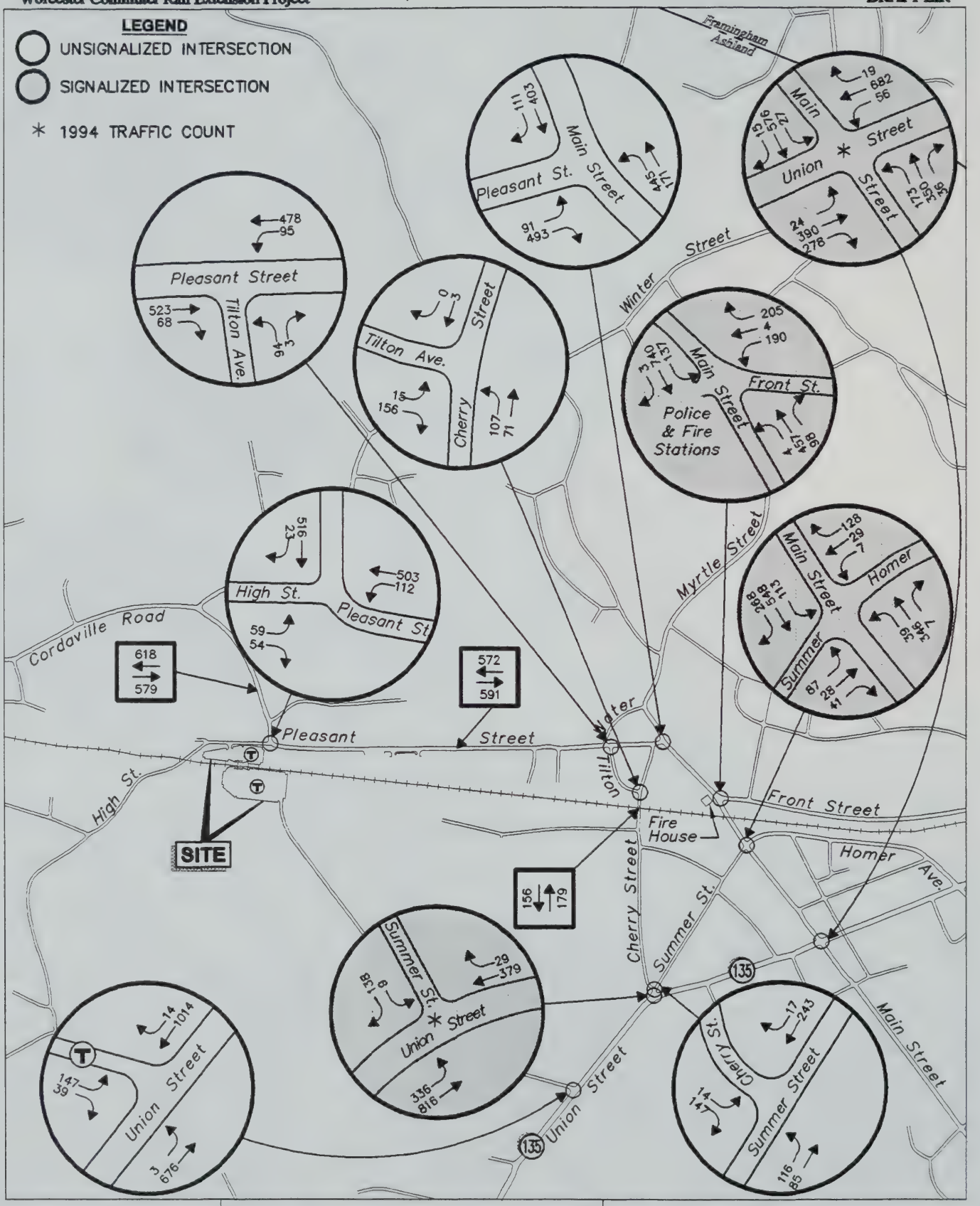


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-11



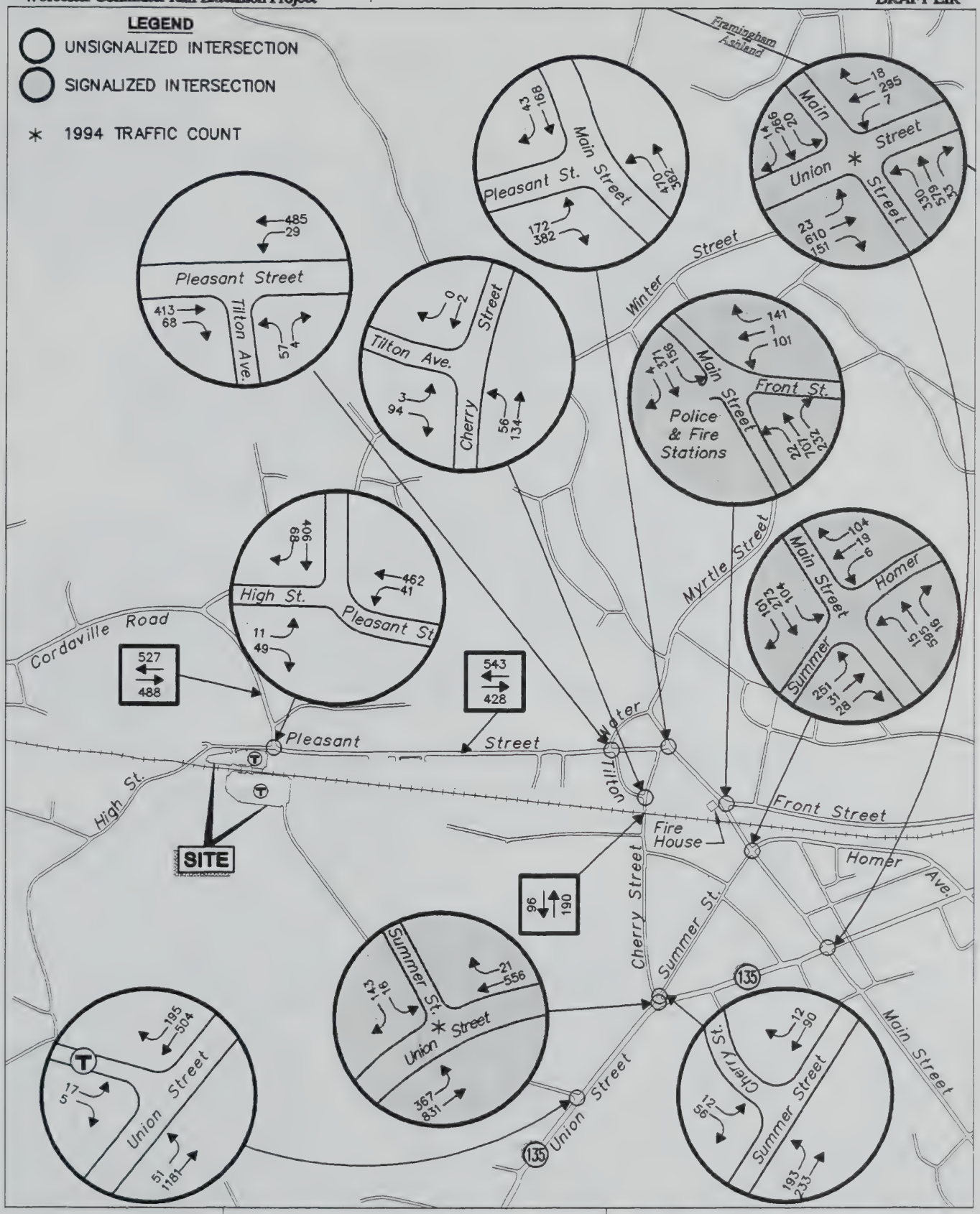
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-12

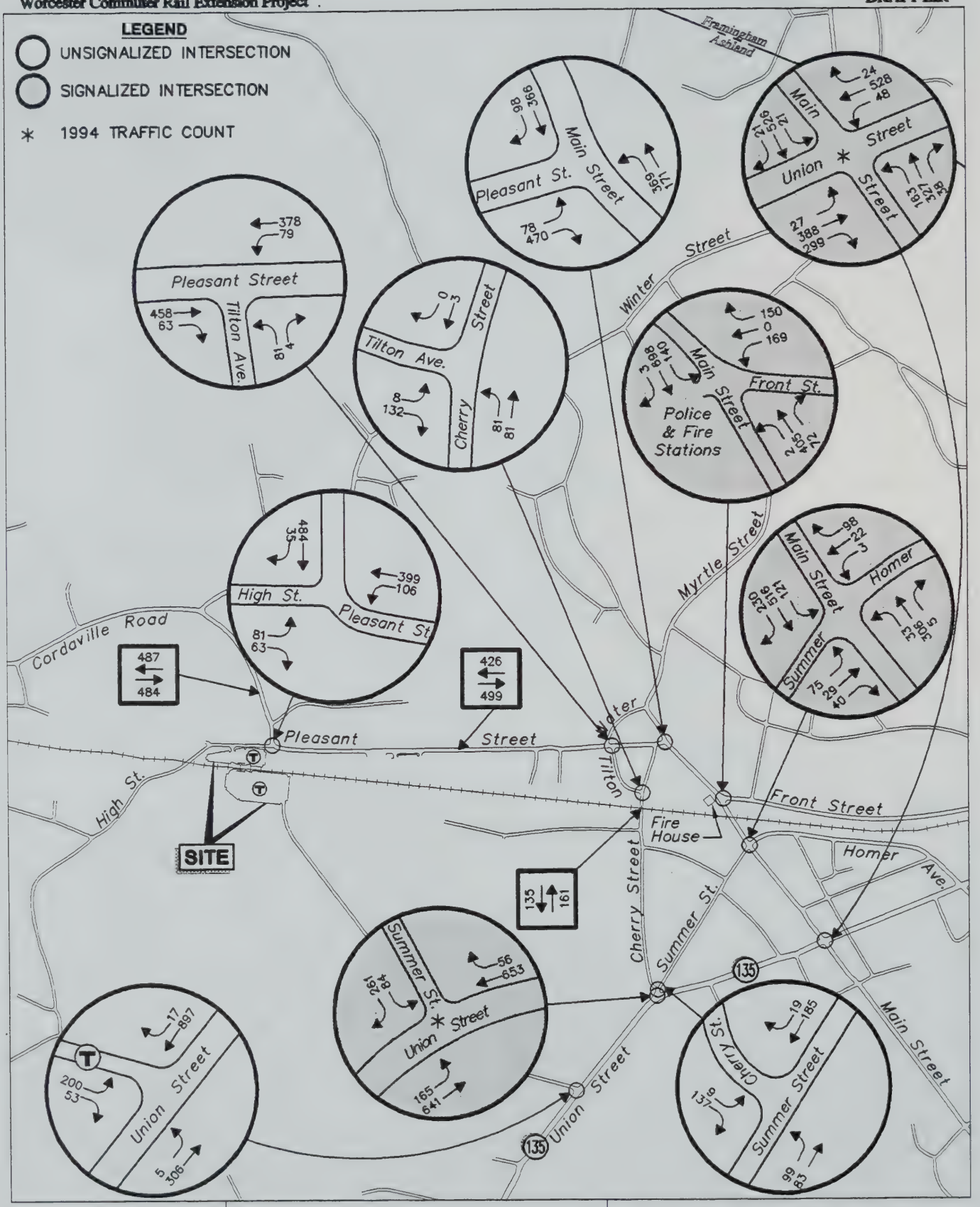


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-13



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-14

Year 1996 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing conditions were analyzed under the 1996 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. This assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 1996 "No Build" condition were not changed from the existing conditions. For the 1996 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.9-6 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 1996 "No Build" and "Build" conditions. Under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at an overall acceptable level of service. During the A.M. peak hour, the northbound approach of Main Street would operate at a LOS "E". During the P.M. peak hour, the southbound approach of Main Street would operate at a LOS rating of "E".

Under the 1996 "Build" condition, the Main Street/Front Street intersection would operate at an overall acceptable level of service rating if the timings are optimized in both the A.M. and P.M. peak hours. The westbound approach will see a LOS rating of "E" in the P.M. peak hour.

Under the 1996 "No Build" condition, the Main Street/Summer Street intersection would operate at an acceptable LOS on all approaches during the P.M. peak hour. During the A.M. peak hour, the intersection would operate at an overall LOS rating of "E" with the eastbound approach of Summer Street and the southbound approach of Main Street operating at a LOS rating of "F".

Table 1.9-6 1996 Peak Hour Signalized Intersection Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(32.2)	D(33.6)	B(10.9)	C(20.9)
Westbound	C(23.2)	D(25.3)	D(33.5)	E(59.9)
Northbound	E(48.7)	C(15.7)	B(10.0)	A(4.5)
Southbound	B(9.4)	E(47.1)	A(2.3)	C(15.8)
Main with Summer	E(42.3)	B(13.8)	E(56.2)	B(7.5)
Eastbound	F(68.8)	C(18.9)	F(139)	C(24.2)
Westbound	C(17.1)	C(17.0)	C(21.6)	C(15.8)
Northbound	B(13.3)	B(7.9)	B(14.9)	A(2.9)
Southbound	F(68.1)	B(14.9)	F(68.3)	B(5.2)
Main with Union	F*	D(28.4)	D(32.1)	E(41.6)
Eastbound	F*	C(17.8)	D(36.8)	E(54.3)
Westbound	B(8.0)	E(58.2)	B(8.8)	E(40.8)
Northbound	C(15.8)	B(12.6)	E(43.1)	E(46.9)
Southbound	B(7.2)	C(16.0)	B(13.9)	C(23.7)
Union with Summer	F*	F*	D(25.2)	F(92.9)
Eastbound	F*	B(13.6)	C(18.0)	E(47.6)
Westbound	F(66.8)	F*	D(29.4)	F(114)
Southbound	B(14.2)	F(64.9)	F(64.7)	F(150)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the 1996 "Build" condition, the Main Street/Summer Street intersection would operate at LOS "F" during the A.M. peak hour even with the optimization of the traffic signal timing. The eastbound Summer Street approach and the northbound Main Street approach will have a LOS rating of "F". During the P.M. peak hour with the retiming of the traffic signal the overall LOS rating can be improved to a very acceptable LOS rating of "B" with no approaches seeing a poor LOS rating.

Under the 1996 "No Build" conditions, the Main Street/Union Street intersection will be operating at an overall unacceptable LOS rating of "F*", this is due to the eastbound Union Street approach having the unacceptable LOS rating of "F*". The other approaches will have acceptable LOS ratings during the A.M. peak hour.

During the P.M. peak hour the overall LOS rating will be acceptable, but the westbound Union Street will have a LOS rating of "E".

Under the "Build" condition, the Main Street/Union Street intersection will operate satisfactorily in both the A.M. and P.M. peak hours. In the P.M. peak hour the intersection will function at LOS "E". The northbound approach will operate at LOS "E" in the A.M. and P.M. peak hours, while the eastbound and westbound approaches will be at LOS "E" in the P.M. peak hour.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" conditions using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" conditions are listed in Table 1.9-7. Under the 1996 "No Build" conditions, most of the intersection movements would operate at an acceptable level of service. The northbound left and right turn movements from Tilton Avenue to Pleasant Street would operate at a LOS "E" during both the A.M. and P.M. peak hours. The eastbound left turn movement from Pleasant Street onto Main Street would operate at an unacceptable LOS "F" during both the A.M. and P.M. peak hours.

Table 1.9-7 1996 Peak Hour Unsignalized Intersection Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(635)	A(442)	A(592)	A(438)
LT and RT from High	B(342)	D(150)	C(294)	E(12)
Pleasant with Tilton				
LT from WB Pleasant	A(601)	A(507)	A(600)	A(495)
LT and RT from Tilton	E(95)	E(26)	E(91)	E(22)
Main with Pleasant				
LT from NB Main	A(493)	B(304)	A(489)	B(304)
LT from Pleasant	F(-81)	F(-4)	F(-84)	F(-15)
RT from Pleasant	A(429)	D(144)	A(429)	D(139)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1070)	A(1121)	A(1070)
LT and RT from Tilton	A(949)	A(848)	A(949)	A(848)
Summer with Cherry				
LT from EB Summer	A(855)	A(785)	A(853)	A(785)
LT and RT from SB Cherry	A(712)	A(590)	A(710)	A(590)
THRU and RT from WB Summer	A(447)	B(341)	A(445)	B(340)
Union with Site's South DW				
LT from EB Union	-	-	A(527)	B(338)
LT from Parking Lot	-	-	E(24)	F(-105)
RT from Parking Lot	-	-	A(478)	C(216)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, most of the analyzed intersection movements would operate at acceptable levels of service. The northbound left and right turns from Tilton Street to Pleasant Street would continue to operate at a LOS rating of "E" during the A.M. and P.M. peak hours. The eastbound left turn from Pleasant Street to Main Street would remain at unacceptable LOS "F" during both the A.M. and P.M. peak hours. The level of service for traffic turning from High Street to Pleasant Street will deteriorate to LOS "E" in the P.M. peak hour.

In addition to the intersections analyzed under the 1992 Existing and 1996 "No Build" scenarios, the intersections of the proposed station access driveway with Union Street was analyzed under the 1996 "Build" conditions. The southbound left turns from the driveway to eastbound Union Street will have an A.M./P.M. peak hour LOS ratings of "E"/"F".

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.9-8 lists the results of this analysis for the A.M. and P.M. peak hours.

Table 1.9-8 1996 Peak Hour Road Segment Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1151)	E(1160)	E(1162)	E(1091)
Pleasant Street East of Site	D(1284)	D(1296)	D(1294)	D(1276)
Cherry Street at Railroad	C(1713)	C(1802)	C(1579)	D(1638)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F"

As shown in the table in the "No Build" condition, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,100 additional vehicles before reaching capacity.

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. Closing of the gates due to train crossings reduces the capacity of the roadway proportional to the length of time the traffic is stopped. As seen in the table, the stopping of traffic for train crossings does not have a significant impact on the flow of traffic along Cherry Street.

Under the 1996 "Build" condition, only Cordaville Road west of the site segment in the A.M. and P.M. roadway peak hours would operate at an level of service rating of "E". Although this roadway segment is listed as LOS "E", the segment can accommodate an additional 1050 vehicles or more before reaching capacity.

Year 1996 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generator hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.9-9 for the 1996 "No Build" and "Build" conditions.

As shown in the table, under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at a LOS "D" during the A.M. and P.M. peak generator hours. The northbound approach of Main Street would operate at a LOS "E". The Main Street/Summer Street intersection would operate at acceptable levels of service on all approaches during the P.M. peak generator hour. During the A.M. peak generator hour, the intersection would operate at an overall LOS "D", with the eastbound Summer Street approach operating at a LOS rating of "F".

In the P.M. peak generator hour all the approaches of the Main Street/Union Street intersection will be operating at acceptable LOS ratings. In the A.M. peak generator hour the overall LOS rating for this intersection will be F*. This is due to the eastbound Union Street's LOS rating being F*. The intersection of Union Street with Summer Street will see both the A.M. and P.M. overall peak generator hour LOS ratings of "F*". In the A.M. peak generator hour it is the eastbound Union Street approach which has the "F*" rating and in the P.M. peak generator hour it is the eastbound Union Street traffic which has the "F*" LOS rating. In addition to the approaches having a LOS rating of "F*", westbound Union Street has a LOS rating of "F" in the A.M. peak generator hour and southbound Summer Street will have a LOS rating of "E" in the P.M. peak generator hour.

Under the "Build" condition, during the A.M. peak generator hour, the Main Street/Front Street intersection would operate at an overall acceptable LOS rating in both the A.M. and P.M. peak generator hours. The westbound Front Street approach will see a LOS rating of "E" in the P.M. peak generator hour. The Main Street/Summer Street intersection will be operating at acceptable LOS ratings in both peak generator hours. In the A.M. peak generator hour the overall LOS rating will be "E", due to the eastbound Summer Street approach being LOS rating "F" and the southbound Main Street approach LOS rating being an "E". The intersection of Main Street/Union Street will see an overall LOS rating of "E" in both the A.M. and P.M. peak generator hours. This is due to the northbound Main Street approach's A.M. and P.M. peak generator LOS rating being "E" and the eastbound Union Street approach's LOS rating being "E" and "F" in the A.M. and P.M. peak generator hours. At the intersection of Union Street/Summer Street, the overall LOS rating will be an acceptable "D" in the A.M. peak generator hour and an unacceptable "F" in the P.M.

peak generator hour. The westbound Union Street approach will have a LOS rating of "E" in the A.M. peak generator hour, while the southbound Summer Street approach will have a LOS rating of "F". During the P.M. peak generator hour all of the approaches will see a LOS rating of "E" or "F".

As with the 1992 Existing condition analysis, approach capacities used for analysis of the intersections of Main Street with Front Street and Main Street with Summer Street were adjusted to account for the additional railroad gate closings. The signal timings were optimized to account for the changes in traffic volumes.

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.9-10. Under the 1996 "No Build" conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during the P.M. hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" and a LOS "E" during the A.M. and P.M. peak generator hours respectively.

Table 1.9-9 1996 Peak Generator Hour Signalized Intersection Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(33.2)	D(28.9)	B(9.3)	C(17.5)
Westbound	C(22.8)	D(25.5)	D(29.8)	E(47.6)
Northbound	E(49.6)	B(14.3)	B(8.1)	A(4.5)
Southbound	B(8.3)	D(38.1)	A(2.1)	B(13.0)
Main with Summer	D(35.2)	C(17.7)	E(47.4)	B(7.5)
Eastbound	F(86.3)	C(18.5)	F(117)	D(25.5)
Westbound	C(16.6)	C(16.7)	C(16.7)	C(15.7)
Northbound	B(13.5)	B(7.7)	C(16.5)	A(2.5)
Southbound	D(35.9)	C(21.4)	E(51.6)	B(5.5)
Main with Union	F*	C(19.5)	E(40.1)	E(43.7)
Eastbound	F*	C(16.7)	E(55.6)	F(71.6)
Westbound	B(8.0)	D(32.9)	B(11.7)	D(25.4)
Northbound	C(15.8)	B(10.2)	E(45.7)	E(48.2)
Southbound	B(7.2)	B(14.6)	B(14.8)	D(25.1)
Union with Summer	F*	F*	D(37.7)	F(81.0)
Eastbound	F*	B(13.0)	D(25.9)	E(42.3)
Westbound	F(63.9)	F*	E(45.7)	F(98.0)
Southbound	B(14.2)	E(42.5)	F(95.6)	F(135)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Table 1.9-10 1996 Peak Generator Hour Unsignalized Intersection Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(627)	A(464)	A(557)	A(457)
LT and RT from High	B(333)	D(160)	C(254)	E(9)
Pleasant with Tilton				
LT from WB Pleasant	A(645)	A(579)	A(644)	A(563)
LT and RT from Tilton	D(129)	E(97)	D(122)	E(89)
Main with Pleasant				
LT from NB Main	A(506)	A(417)	A(499)	A(416)
LT from Pleasant	F(-71)	E(57)	F(-76)	E(42)
RT from Pleasant	A(463)	C(200)	A(462)	D(139)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1069)	A(1121)	A(1096)
LT and RT from Tilton	A(954)	A(900)	A(954)	A(900)
Summer with Cherry				
LT from EB Summer	A(874)	A(858)	A(869)	A(858)
LT and RT from SB Cherry	A(696)	A(679)	A(692)	A(678)
THRU and RT from WB Summer	A(457)	A(434)	A(452)	A(432)
Union with Site's South DW				
LT from EB Union	-	-	A(467)	B(391)
LT from Parking Lot	-	-	E(13)	F(-88)
RT from Parking Lot	-	-	A(463)	C(250)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, the analyzed intersection movements would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during the P.M. peak generator hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" during the A.M. peak generator hour, and at a LOS "E" during the P.M. peak generator hour. The level of service for traffic turning from High Street to Pleasant Street will deteriorate to LOS "E" in the P.M. generator hour.

The intersection of Union Street at the proposed site driveway was also analyzed. Left turning traffic from the driveway heading east on Union Street will have an A.M./P.M. LOS rating of "E" and "F", respectively.

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 1996 "No Build" and "Build" conditions. Table 1.9-11 lists the results of this analysis for the A.M. and P.M. peak generator hours.

Table 1.9-11 1996 Peak Generator Hour Road Segment Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1221)	D(1347)	E(1250)	E(1348)
Pleasant Street East of Site	D(1339)	D(1481)	D(1370)	D(1472)
Cherry Street at Railroad Grade Crossing	C(1684)	C(1834)	D(1511)	C(1712)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table, for the "No Build" condition, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,200 additional vehicles before reaching capacity.

Under the "Build" condition, all roadway segments during the A.M. and P.M. peak generator hours would operate at an acceptable level of service. Although the roadway segment of Cordaville Road west of the site is listed as LOS "E", this road segment can accommodate an additional 1,250 vehicles or more before reaching capacity.

The roadway segment analysis performed for Cherry Street at the railroad crossing demonstrates that additional gate closings during peak generator hours do not significantly impact the flow of traffic along Cherry Street.

Year 1996 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.9-12 lists the site

generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in Table 1.9-12, no intersection would receive 10 percent or more of its 1996 "Build" traffic from the proposed rail station during roadway peak hours.

As shown in Table 1.9-12, no roadway segments would receive 10 percent on more of their 1996 "Build" traffic volume from the proposed commuter rail station during the A.M. and P.M. peak hours.

Table 1.9-12 1996 "Build" Condition - 10% Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Pleasant with High	4.2%	4.3%
Pleasant and Site's West	4.8%	4.5%
Pleasant and Site East	5.0%	5.6%
Pleasant and Tilton	1.2%	1.4%
Main and Pleasant	0.8%	1.0%
Main and Front	0.2%	0.3%
Main and Summer	0.0%	0.0%
Main and Union	6.1%	6.4%
Cherry with Tilton	0.0%	0.0%
Summer with Cherry	0.3%	0.5%
Union with Summer	7.4%	8.9%
Union with Site's South	9.6%	9.5%
Roadway Segment		
Cordaville Rd. West	3.7%	4.5%
Pleasant St. East	1.3%	1.5%
Cherry St. at Railroad	0.0%	0.0%

Site generated traffic as a percentage of total traffic

Year 1996 Ashland Station Only

To determine the impacts to the study area for the Ashland Station, if for some reason the other suburban stations are delayed in coming into service an "Ashland Station Only" analysis was performed. This analysis assumes that Ashland is the only station built by 1996 (in addition to a Worcester Station). As done for the year 1996 analysis the conditions will be a base "No Build" to be compared against a "Build" condition

to determine the impacts of the commuter rail station. The standard assumptions were made that no significant changes, additions, or deletions will be made to the roadway network.

The 1996 "No Build" volumes, for both peak hours and peak generator hours were previously presented and serve as the same base for the "Ashland Station Only" analysis as they did for the "Build All Stations" scenario.

Year 1996 Trip Generation/Parking (Ashland Station Only)

In support of this study, the Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension should the service to Worcester include stopping only in Ashland in between Worcester and Framingham stations. The CTPS projected that by the year 2011, a total of 2,701 persons are expected to utilize the railroad for daily round trip commuting into Boston, if adequate parking can be developed.

In the year 1996, the proposed Ashland Station is projected to attract a total of 1,041 daily round trip commuters. Twenty of these patrons would walk to the station, while an additional 82 patrons would be dropped off. Based upon an average automobile occupancy rate of 1.12, the remaining 939 Park'n'Ride patrons would result in a parking demand of 840 parking spaces.

The patrons who will use the Ashland Station are projected to reside in the Towns of Ashland, Holliston, Hopkinton, Marlborough, Southborough, and Westborough. Based on the proposed station location, all 20 of the patrons who walk to the station will reside in the Town of Ashland. The number of patrons who originate from each Town during the peak commuting periods shown in Table 1.9-13.

Six percent of the total ridership is expected to occur outside of the peak A.M. and P.M. commuting periods, thus the 1,041 daily ridership was reduced to 978 riders during the peak commuting hours.

Table 1.9-13 Projected Patrons of Ashland Station - Year 1996 (Ashland Station Only)

Town	Riders*
Ashland	354**
Holliston	262
Hopkinton	92
Marlborough	171
Southborough	76
Westborough	23
Total	**978**

* *Adjusted for peak period demand*
** *Includes 19 walk trips from Ashland*

Year 1996 Trip Distribution and Assignment (Ashland Station Only)

Not all of the projected ridership will arrive at the station at the same time, or even during the same peak hour. Ridership on each train will very depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier or later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand than those that depart at other times.

The total ridership will be divided between four inbound trains during the A.M. peak period and five outbound trains during and after the P.M. peak period. The patrons would not be evenly distributed on the available trains. The ridership per train was determined using regression equations based on arrival and departure time in Boston and the time between trains. Details of the development of these equations are presented in Section 1.1 of this report.

Table 1.9-14 lists projected distribution of ridership based on arrival/departure time in Boston.

Table 1.9-14 MBTA Ridership Distribution - (Ashland Station Only)	
Inbound Train	**Patrons**
502A	192
504A	317
506A	317
510	152
Total	**978**
Outbound Train	**Patrons**
515A	137
519A	227
521	226
521A	339
523	49
Total	**978**

Commuters who will utilize the rail service will typically sacrifice some additional travel time for the convenience of not driving downtown in rush hour traffic, and the cost savings in parking and tolls. The commuters who shift to commuter rail will shift their local departure and arrival times since their commuting time is typically longer than travelling by automobile. This change in commuting time results in the A.M. and P.M. peak hours for the site to lie totally or partially outside the standard hours of 7:00 to 9:00 A.M. and 4:00 to 6:00 P.M. Thus, there because a need to analyze two peak hours; the roadway peak hour and the commuter rail stations peak generator hour.

The peak generator hours were determined by analyzing the A.M. departure and P.M. arrivals in 15 minute intervals at the Ashland Station. The arrivals were estimated to occur uniformly over a 15 minute arrival period followed by a 5 minute waiting period. The departures were assumed to occur uniformly over a 15 minute period with the train to vehicle time being 2 to 4 minutes on average.

In Ashland the typical A.M. and P.M. roadway peak hours are from 7:30 to 8:30 A.M. and from 5:00 to 6:00 P.M. With the proposed commuter rail schedule the peak generator hours for the commuter rail station will be from 7:15 to 8:15 A.M. and from 5:30 to 6:30 P.M.

Once the projected generated vehicle trips were distributed overtime, the resulting peak hour totals were assigned to the study are roadway system. Patrons who reside in Ashland would utilize a variety of travel routes, depending on the location of their

residence. Riders originating in towns outside that in which the station is located were assigned to the major roadways leading from their town to the proposed station.

Patrons from Marlborough, Southborough, and Westborough would access the station's northern parking lot via Cordaville Road. Patrons from Holliston would access the station's southern parking lot via Main Street and Route 135. Patrons from Hopkinton will access the southern parking lot via Route 135. Actual routing was estimated based on the shortest travel time and distance from population centers. Figure 1.9-15 shows the percentage of station related traffic utilizing the study area roadways for the 1996 "Build" condition.

Upon completion of the commuter rail service, commuters will shift form automobile only usage to automobile/rail usage to travel to Boston. Work vehicle trips will be of a shorter duration. Traffic volumes are expected to decrease along most portions of Route 135 and 126, Route 9, and the Mass Pike. Traffic volumes are expected to increase on the sections of Cordaville Road, Main Street, Pleasant Street, and Union Street near the commuter rail station.

Year 1996 "Build" Traffic Volumes (Ashland Station Only)

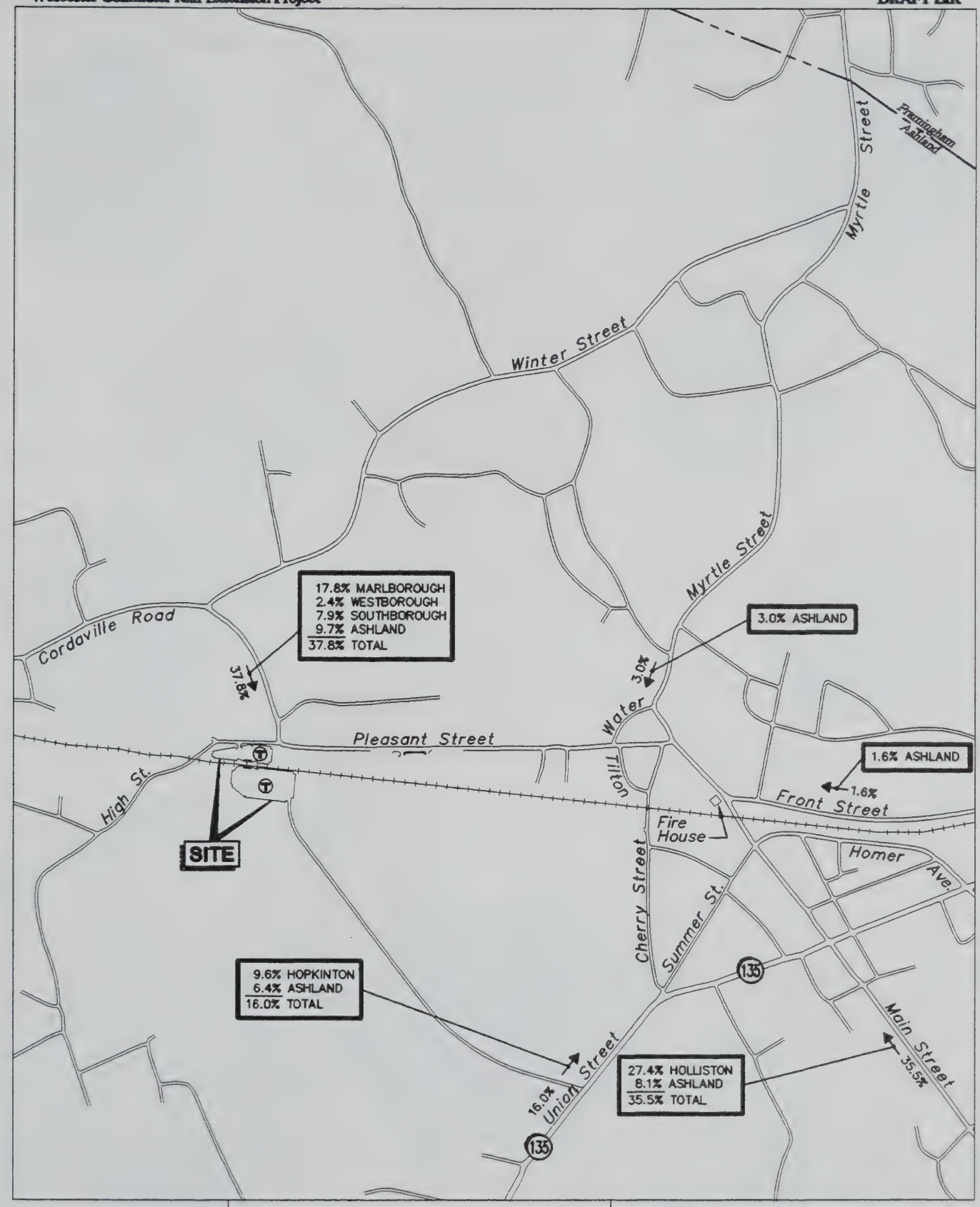
Traffic volumes under the year 1996 "Build" conditions consist of two primary elements:

- The projected 1996 "No Build" traffic volumes
- Traffic specifically diverted to the proposed Ashland Rail Station.

A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Ashland Center, which includes Pleasant Street, Union Street, and Main Street. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reductions in volume on specific roadways including Pleasant Street. This results in a "worst case" analysis. Figures 1.9-16 and 1.9-17 show the A.M. and P.M. peak hour traffic volumes. Figures 1.9-18 and 1.9-19 show the A.M. and P.M. peak generator hour traffic volumes.

Year 1996 Peak Hour Levels of Service (Ashland Station Only)

The same study area elements that were analyzed under the 1992 existing conditions were analysis under the 1996 "No Build" and "Build" Ashland Station Only conditions. The analysis was performed using the "all else being equal" assumption this assumes that the traffic volumes are the only parameter in the analysis to change from the existing conditions. Roadway geometrics remain unchanged. Signal timings

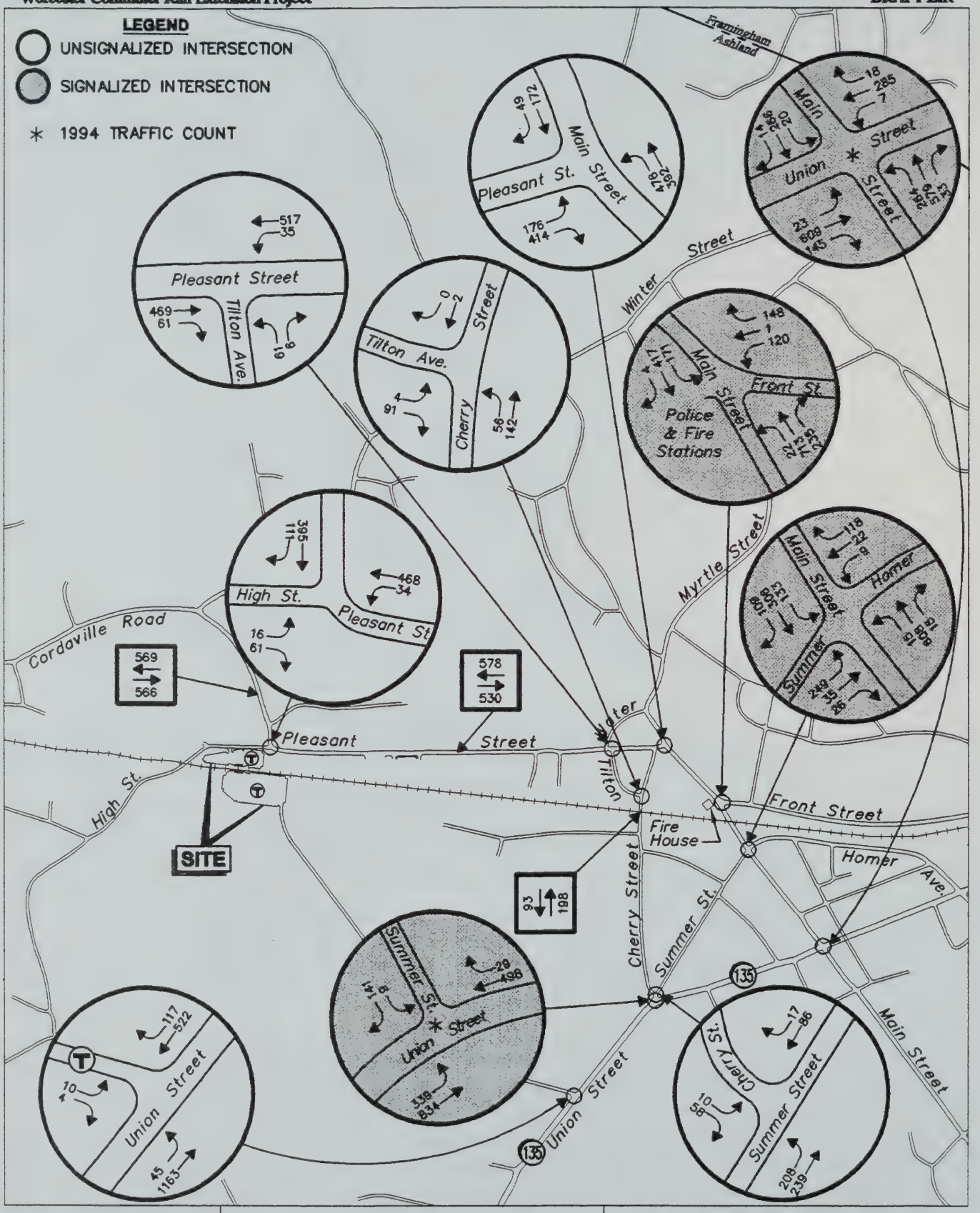


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

Distribution of Commuter Rail Station Traffic 1996 BUILD Ashland Only ASHLAND STATION-WEST

FIGURE 1.9-15



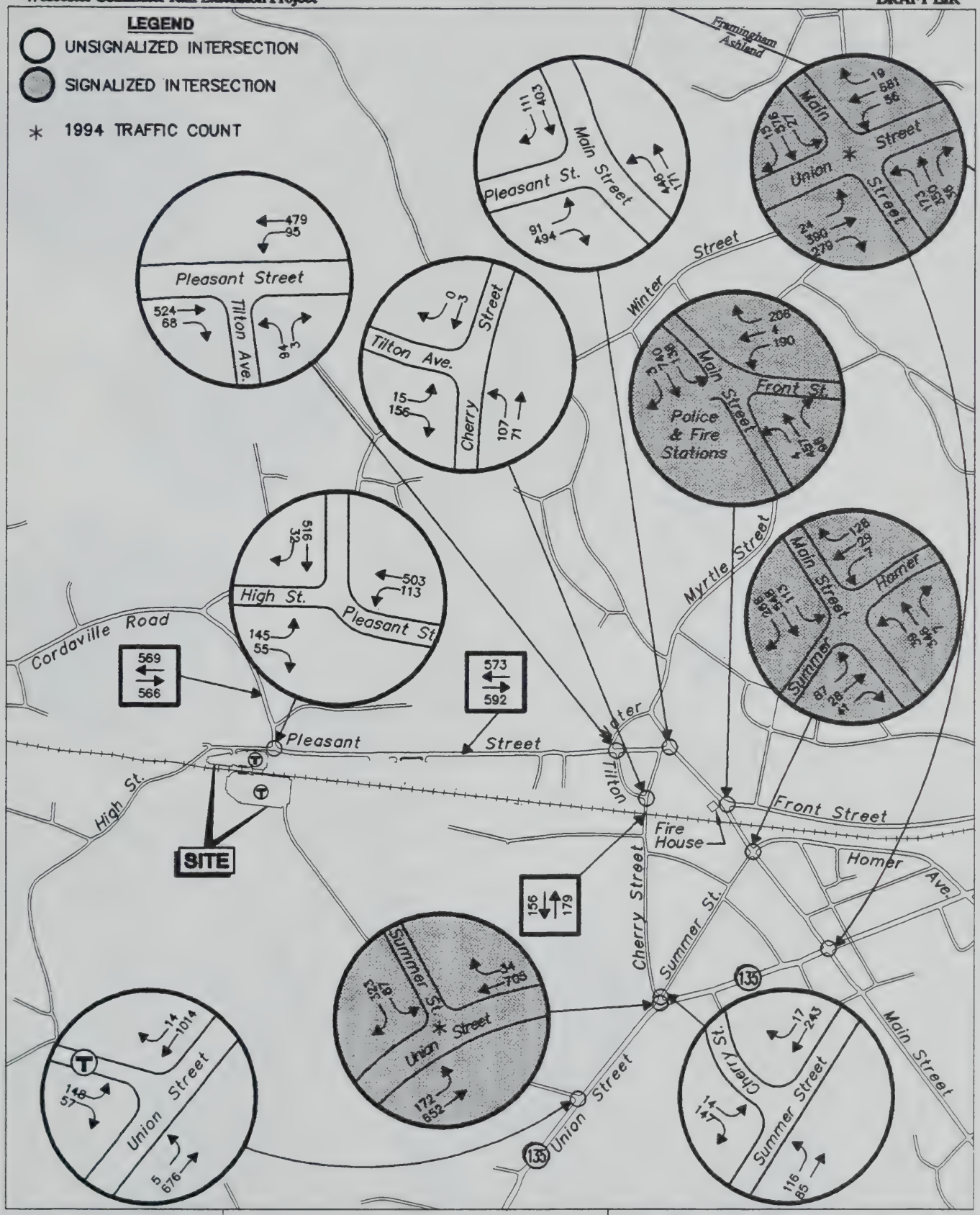
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
1996 BUILD Ashland Only
ASHLAND STATION-WEST

FIGURE 1.9-16



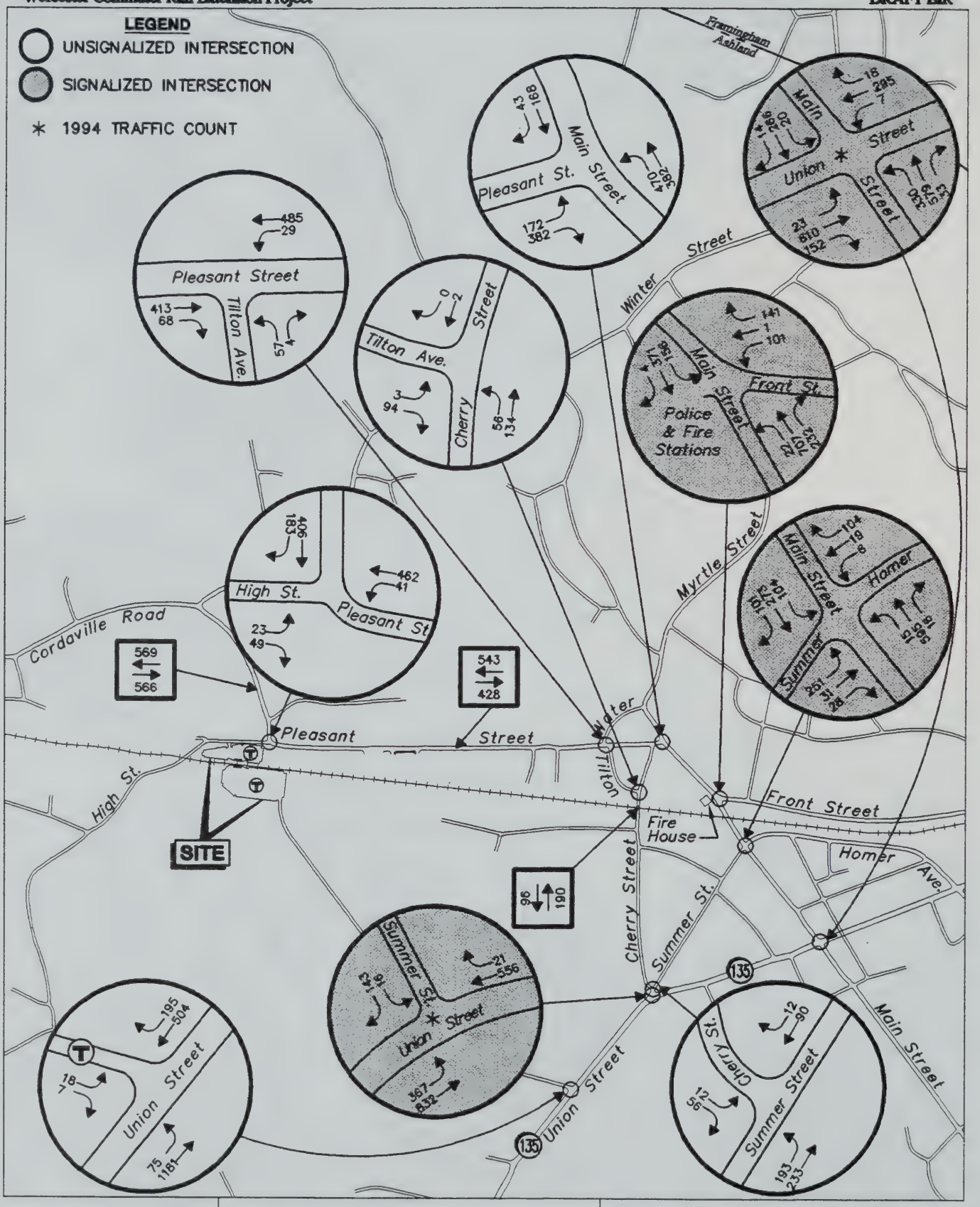
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
1996 BUILD Ashland Only
ASHLAND STATION-WEST

FIGURE 1.9-17

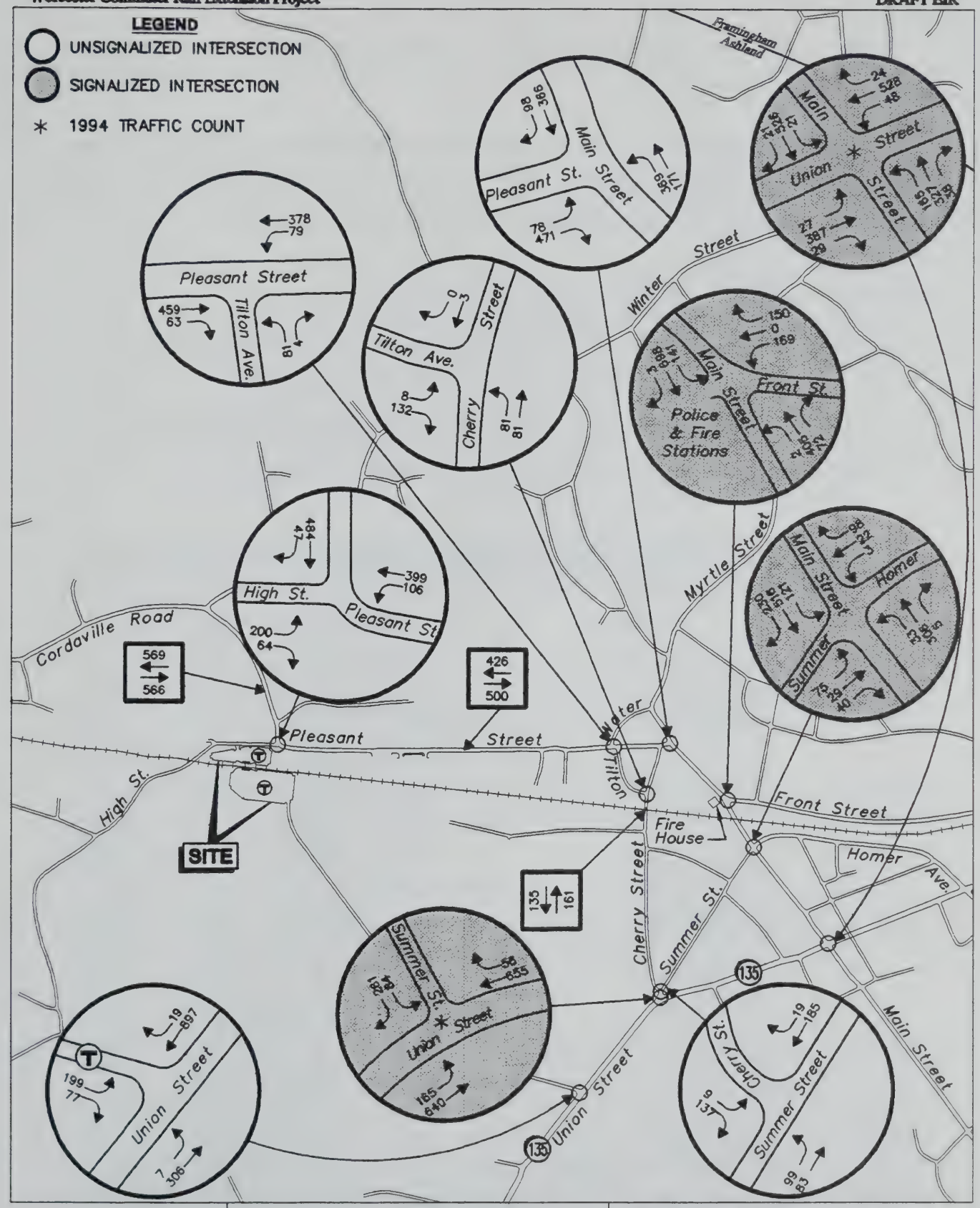


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
1996 BUILD Ashland Only
ASHLAND STATION-WEST

FIGURE 1.9-18



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
1996 BUILD Ashland Only
ASHLAND STATION-WEST

FIGURE 1.9-19

for the 1996 "No Build" conditions were not changed from the existing conditions. For the 1996 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.9-15 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 1996 "No Build" and "Build" Ashland Station Only conditions. Under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at an overall acceptable level of service. During the A.M. peak hour, the northbound approach of Main Street would operate at a LOS rating of "E". During the P.M. peak hour, the southbound approach of Main Street would operate at a LOS rating of "E".

Table 1.9-15 1996 Peak Hour Signalized Intersection Levels of Service (Ashland Station Only)

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(32.2)	D(33.6)	B(10.9)	C(21.1)
Westbound	C(23.2)	D(25.3)	D(33.5)	F(60.6)
Northbound	E(48.7)	C(15.7)	B(10.0)	A(4.5)
Southbound	B(9.4)	E(47.1)	A(2.3)	C(15.8)
Main with Summer	E(42.3)	B(13.8)	E(56.2)	B(7.5)
Eastbound	F(68.8)	C(18.9)	F(139)	C(24.2)
Westbound	C(17.1)	C(17.0)	C(21.6)	C(15.8)
Northbound	B(13.3)	B(7.9)	B(14.9)	A(2.9)
Southbound	F(68.1)	B(14.9)	F(68.3)	B(5.2)
Main with Union	F*	D(28.4)	D(32.0)	E(41.7)
Eastbound	F*	C(17.8)	D(36.4)	E(54.8)
Westbound	B(8.0)	E(58.2)	B(8.8)	E(40.5)
Northbound	C(15.8)	B(12.6)	E(43.1)	E(46.9)
Southbound	B(7.2)	C(16.0)	B(13.9)	C(23.7)
Union with Summer	F*	F*	D(25.2)	F(92.8)
Eastbound	F*	B(13.6)	C(18.0)	E(47.6)
Westbound	F(66.8)	F*	D(29.4)	F(114)
Southbound	B(14.2)	E(64.9)	F(64.7)	F(150)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the 1996 "Build" Ashland Station Only condition, the Main Street/Front Street intersection would operate at an overall acceptable level of service rating if the signal timings are optimized in both the A.M. and P.M. peak hours. Only the westbound approach will see an unacceptable LOS rating of "F" and only in the P.M. peak hour.

Under the 1996 "No Build" condition, the Main Street/Summer Street intersection would operate at an acceptable LOS rating on all approaches during the P.M. peak hour. During the A.M. peak hour, the intersection would operate at an overall LOS rating of "E" with the eastbound approach of Summer Street and the southbound approach of Main Street operating at A LOS rating of "F".

Under the 1996 "Build" condition, the Main Street/Summer Street intersection with optimized timing, would operate at LOS "E" in the A.M. peak hour with both the eastbound and southbound approaches at LOS "F". During the P.M. peak hour, the intersection will function at LOS "B" with all approaches operating acceptably,.

In the "No Build" condition, the Main Street/Union Street intersection will function at an unacceptable LOS "F" in the A.M. peak hour. The eastbound approach will also operate at LOS "F". In the P.M. peak hour the intersection operates acceptably. The westbound approach will be at LOS "E".

With optimization of the signal timing, the intersection will improve to LOS "D" in the A.M. peak hour "Build" condition. The northbound approach will operate at LOS "E". Level of service will decline to LOS "E" in the P.M. peak hour with three approaches also operating at LOS "E".

In the "No Build" condition, the Union Street/Summer Street intersection will operate at LOS "F" in both peak hours. Both the eastbound and westbound approaches will function at LOS "F".

In the "Build" condition, operations at the intersection can be improved to an acceptable level of service in the A.M. peak hour by improving the signal timing. In the P.M. peak hour, level of service will be reduced to LOS "E". Three of the approaches will also operate at LOS "E" in the P.M. peak hour.

Unsignalized Intersections

The unsignalized intersections were analyzed under the year 1996 "No Build" and "Build" Ashland Station Only conditions using the same methodology as with the existing conditions analysis. Results of the A.M. and P.M. peak roadway hour analysis for the year 1996 "No Build" and "Build" Ashland Station Only conditions are listed in Table 1.9-16. Under the 1996 "No Build" conditions, most of the intersection movements would operate at an acceptable level of service. The northbound left and right turn movements from Tilton to Pleasant Street would operate at a LOS rating of "E" during both the A.M. and P.M. peak hours. The eastbound left turn movement

from Pleasant Street onto Main Street would operate at a LOS rating of "F" during both the A.M. and P.M. peak hours.

Table 1.9-16 1996 Peak Hour Unsignalized Intersection Level of Service (Ashland Station Only)

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(635)	A(442)	A(540)	A(431)
LT and RT from High	B(342)	D(150)	C(220)	F(-103)
Pleasant with Tilton				
LT from WB Pleasant	A(601)	A(507)	A(600)	A(495)
LT and RT from Tilton	E(95)	E(26)	E(91)	E(21)
Main with Pleasant				
LT from NB Main	A(493)	B(304)	A(489)	B(303)
LT from Pleasant	F(-81)	F(-4)	F(-84)	F(-16)
RT from Pleasant	A(429)	D(144)	A(429)	D(138)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1070)	A(1121)	A(1070)
LT and RT from Tilton	A(949)	A(848)	A(949)	A(848)
Summer with Cherry				
LT from EB Summer	A(855)	A(785)	A(853)	A(785)
LT and RT from SB Cherry	A(712)	A(590)	A(710)	A(590)
THRU and RT from WB Summer	A(447)	B(341)	A(445)	B(340)
Union with Site's South DW				
LT from EB Union	-	-	A(513)	B(336)
LT from Parking Lot	-	-	E(23)	F(-106)
RT from Parking Lot	-	-	A(477)	D(198)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" conditions, most of the analyzed intersections would operate at acceptable levels of service. The northbound left and right turns from Tilton Street to Pleasant Street would operate at a LOS rating of "E" during the A.M. and P.M. peak hours. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS rating of "F" during both the A.M. and P.M. peak hours.

In addition to the intersections analyzed under the 1992 existing and 1996 "No Build" scenarios, the intersection of the proposed station access driveway to Union Street was analyzed under the 1996 "Build" conditions. The southbound left turns from the driveway to eastbound Union Street will have A.M./P.M. peak hour LOS ratings of "E"/"F".

Road Segments

The roadway segments discussed in the existing conditions wee also analyzed for level of service under the 1996 "No Build" and "Build" Ashland Station Only conditions. Table 1.9-17 lists the results of this analysis for the A.M. and P.M. peak hours.

Table 1.9-17 1996 Peak Hour Road Segment Level of Service (Ashland Station Only)

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1151)	E(1160)	E(1052)	E(961)
Pleasant Street East of Site	D(1284)	D(1296)	D(1295)	D(1274)
Cherry Street at Railroad Grade Crossing	C(1713)	C(1802)	C(1590)	C(1638)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table in the "No Build" condition, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS rating of "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,100 additional vehicles before reaching capacity.

The Cherry Street road segment was selected for analysis due to the existing at-grade railroad crossing. Closing of the gates due to train crossings reduces the capacity of the roadway proportional to the length of time the traffic is stopped. As seen in Table 1.9-17, the stopping of traffic for train crossing does not have a significant impact on the flow of traffic along Cherry Street.

Under the 1996 "Build" condition, only the Cordaville Road segment west of the site in the A.M. and P.M. roadway peak hours would operate at a level of service rating of "E". Although this roadway segment is listed as a LOS rating of "E" the segment can accommodate an additional 950 vehicles or more before reaching capacity.

Year 1996 Peak Generator Hour Level of Service (Ashland Station Only)

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.9-18 for the 1996 "No Build" and "Build" conditions.

As shown in the table, under the 1996 "No Build" conditions, the Main Street/Front Street intersection would operate at a LOS rating of "D" or better during the A.M. and P.M. peak hours. The northbound approach of Main Street would operate at a LOS rating of "E". The Main Street/Summer Street intersection would operate at acceptable levels of service an all approaches during the P.M. peak generator hour. During the A.M. peak generator hour, the intersection would operate at an overall LOS rating of "D", with the eastbound Summer Street approach operating at a LOS rating of "F".

In the P.M. peak generator hour all the approaches of the Main Street/Union Street intersection will be operating at acceptable LOS ratings. In the A.M. peak generator hour the overall LOS rating for this intersection will be F*, this is due to the eastbound Union Street LOS rating being F*. The intersection of Union Street with Summer Street will see both the A.M. and P.M. peak generator hour overall LOS rating of "F*". In the A.M. peak generator hour it is the eastbound Union Street approach which has the "F*" rating. In the P.M. peak generator hour it is the eastbound Union Street traffic which has the "F*" LOS rating. In addition to the approaches having a LOS rating of "F*", the westbound Union Street has a LOS rating of "F" in the A.M. peak generator hour and the southbound Summer Street approach will have a LOS rating of "E" in the P.M. peak generator hour.

Under the "Build" condition, during the A.M. peak generator hour, the Main Street/Front Street intersection would operate at an overall acceptable LOS rating in both the A.M. and P.M. peak generator hours. The westbound Front Street approach will see a LOS rating of "E" in the P.M. peak generator hour. In the P.M. peak generator hour the Main Street/Summer Street intersection will be operating at acceptable LOS ratings on all approaches. In the A.M. peak generator hour the overall LOS rating will be "E", due to the eastbound Summer Street approach LOS rating being "F" and the southbound Main Street approach LOS rating being an "E". The intersection of Main Street/Union Street will see an overall LOS rating of "E" in both the A.M. and P.M. peak generator hours. This is due to the northbound Main Street approach's A.M. and P.M. peak generator LOS rating being "E" and the eastbound Union Street approach's LOS rating being "E" and "F" in the A.M. and P.M. peak generator hours, respectively. At the intersection of Union Street/Summer Street, the overall LOS rating will be "D" in the A.M. peak generator hour and an unacceptable "F" in the P.M. peak generator hour. The westbound Union Street approach will have a LOS rating of "E" in the A.M. peak generator hour, while the

southbound Summer Street approach will have a LOS rating of "F". During the P.M. peak generator hour all of the approaches will see a LOS rating of "E" or "F".

As with the 1992 existing conditions analysis, the approach capacities used for the analysis of the intersections of Main Street with Front Street and Main Street with Summer Street and Homer Avenue were adjusted to account for the additional railroad gate closings. The signal timings were optimized to account for the changes in traffic volumes.

Table 1.9-18 1996 Peak Generator Hour Signalized Intersection Levels of Service (Ashland Station Only)

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	D(33.2)	D(28.9)	B(9.3)	C(17.5)
Westbound	C(22.8)	D(25.5)	D(29.8)	E(47.6)
Northbound	E(49.6)	B(14.3)	B(8.1)	A(4.5)
Southbound	B(8.3)	D(38.1)	A(2.1)	B(13.0)
Main with Summer	D(35.2)	C(17.7)	E(47.4)	B(7.5)
Eastbound	F(86.3)	C(18.5)	F(117)	D(25.5)
Westbound	C(16.6)	C(16.7)	C(16.7)	C(15.7)
Northbound	B(13.5)	B(7.7)	C(16.5)	A(2.5)
Southbound	D(35.9)	C(21.4)	E(51.6)	B(5.5)
Main with Union	F*	C(19.5)	E(40.3)	E(44.0)
Eastbound	F*	C(16.7)	E(56.1)	F(71.0)
Westbound	B(8.0)	D(32.9)	B(11.9)	D(25.4)
Northbound	C(15.8)	B(10.2)	E(45.7)	E(50.6)
Southbound	B(7.2)	B(14.6)	B(14.8)	D(25.1)
Union with Summer	F*	F*	D(37.7)	F(81.7)
Eastbound	F*	B(13.0)	D(25.9)	E(42.5)
Westbound	F(63.9)	F*	E(45.7)	F(98.8)
Southbound	B(14.2)	E(42.5)	F(95.6)	F(136)

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.9-19. Under the 1996 "No Build" conditions, the analyzed intersections would for the most part operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS rating of "E" during the P.M. peak generator hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS rating of "F" and a LOS rating of "E" during the A.M. and P.M. peak generator hours, respectively.

Table 1.9-19 1996 Peak Generator Hour Unsignalized Intersection Level of Service (Ashland Station Only)

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(627)	A(464)	A(496)	A(449)
LT and RT from High	B(333)	D(160)	D(155)	F(-140)
Pleasant with Tilton				
LT from WB Pleasant	A(645)	A(579)	A(644)	A(562)
LT and RT from Tilton	D(129)	E(97)	D(122)	E(89)
Main with Pleasant				
LT from NB Main	A(506)	A(417)	A(499)	A(416)
LT from Pleasant	F(-71)	E(57)	F(-76)	E(42)
RT from Pleasant	A(463)	C(200)	A(462)	D(192)
Cherry with Tilton				
LT from NB Cherry	A(1121)	A(1096)	A(1121)	A(1096)
LT and RT from Tilton	A(954)	A(900)	A(954)	A(900)
Summer with Cherry				
LT from EB Summer	A(874)	A(858)	A(869)	A(858)
LT and RT from SB Cherry	A(696)	A(679)	A(692)	A(678)
THRU and RT from WB Summer	A(457)	B(434)	A(452)	A(432)
Union with Site's South DW				
LT from EB Union	-	-	A(443)	B(388)
LT from Parking Lot	-	-	E(9)	F(-88)
RT from Parking Lot	-	-	A(461)	C(226)

LOS (Reserve Capacity-Vehicles)

Under the 1996 "Build" the Ashland Station only conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS rating of "E" during the P.M. peak generator hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS rating of "F" during the A.M. peak generator hour, and at a LOS rating of "E" during the P.M. peak generator hour.

The intersection of the site driveway Union Street was also analyzed during the A.M. and P.M. peak generator hours. The left turning traffic from the south driveway heading east on Union Street will have an A.M./P.M. LOS rating of "E"/"F".

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for levels of service under the 1996 "No Build" and "Build" Ashland Station Only conditions. Table 1.9-20 lists the results of this analysis for the A.M. and P.M. peak generator hours.

Table 1.9-20 1996 Peak Generator Hour Road Segment Level of Service (Ashland Station Only)

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1221)	D(1347)	E(1055)	E(1148)
Pleasant Street East of Site	D(1339)	D(1481)	D(1370)	D(1575)
Cherry Street at Railroad Grade Crossing	C(1684)	C(1834)	D(1511)	C(1712)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

As shown in the table, for the "No Build" condition all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS rating of "E" under the "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,200 additional vehicles before reaching the LOS rating of "F".

Under the "Build" Ashland Station Only conditions, all roadway segments during the A.M. and P.M. peak generator hours would operate at an acceptable level of service. Although several roadway segments of Cordaville Road west of the site is listed as a LOS rating of "E", this road segment accommodates an additional 1,250 vehicles or more before reaching capacity.

The roadway segment analysis performed for Cherry Street at the railroad crossing demonstrates that additional gate closing during the peak generator hours do not significantly impact the flow of traffic along Cherry Street.

Year 1996 Ten Percent of Traffic Analysis (Ashland Station Only)

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.9-21 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. peak roadway hours.

As shown in the Table 1.9-21, four intersections would have 10 percent or more of their traffic from the proposed rail station during the roadway peak hours. The intersections are:

- Pleasant Street with High Street
- Pleasant Street with Site's West Driveway
- Pleasant Street with Site's East Driveway
- Pleasant Street with Site's South Driveway

One roadway segment would receive over 10 percent from the proposed rail station. Cordaville Road, west of the site's driveways, would exceed the 10 percent criteria during the A.M. and P.M. peak hours.

The portion of total "Build" traffic exceeding 10 percent ranges from 10.4 percent to 13.3 percent.

Table 1.9-21 1996 Condition - 10% Analysis (Ashland Station Only)

Intersection	Peak Hours	
	A.M.	P.M.
Pleasant with High	12.3%	12.2%
Pleasant and Tilton	1.1%	1.5%
Main and Pleasant	0.8%	1.1%
Main and Front	0.2%	0.4%
Main and Summer	0.0%	0.0%
Main and Union	6.1%	6.4%
Cherry with Tilton	0.0%	0.0%
Summer with Cherry	0.3%	0.5%
Union with Summer	7.4%	8.9%
Union with Site's South	10.4%	9.6%
Roadway Segment		
Cordaville Rd. West	10.7%	12.7%
Pleasant St. East	1.2%	1.7%
Cherry St. at Railroad	0.0%	0.0%

Site generated traffic as a percentage of total traffic

Year 2001 Conditions

Similar to the year 1996 conditions, an analysis was performed for the projected "No Build" and "Build" traffic conditions in the year 2001. Procedures and methodology for this analysis were the same as in the 1996 condition analysis. A detailed description of the analysis methodology is presented in Section 1.1 of this report.

Year 2001 "No Build" Traffic Volumes

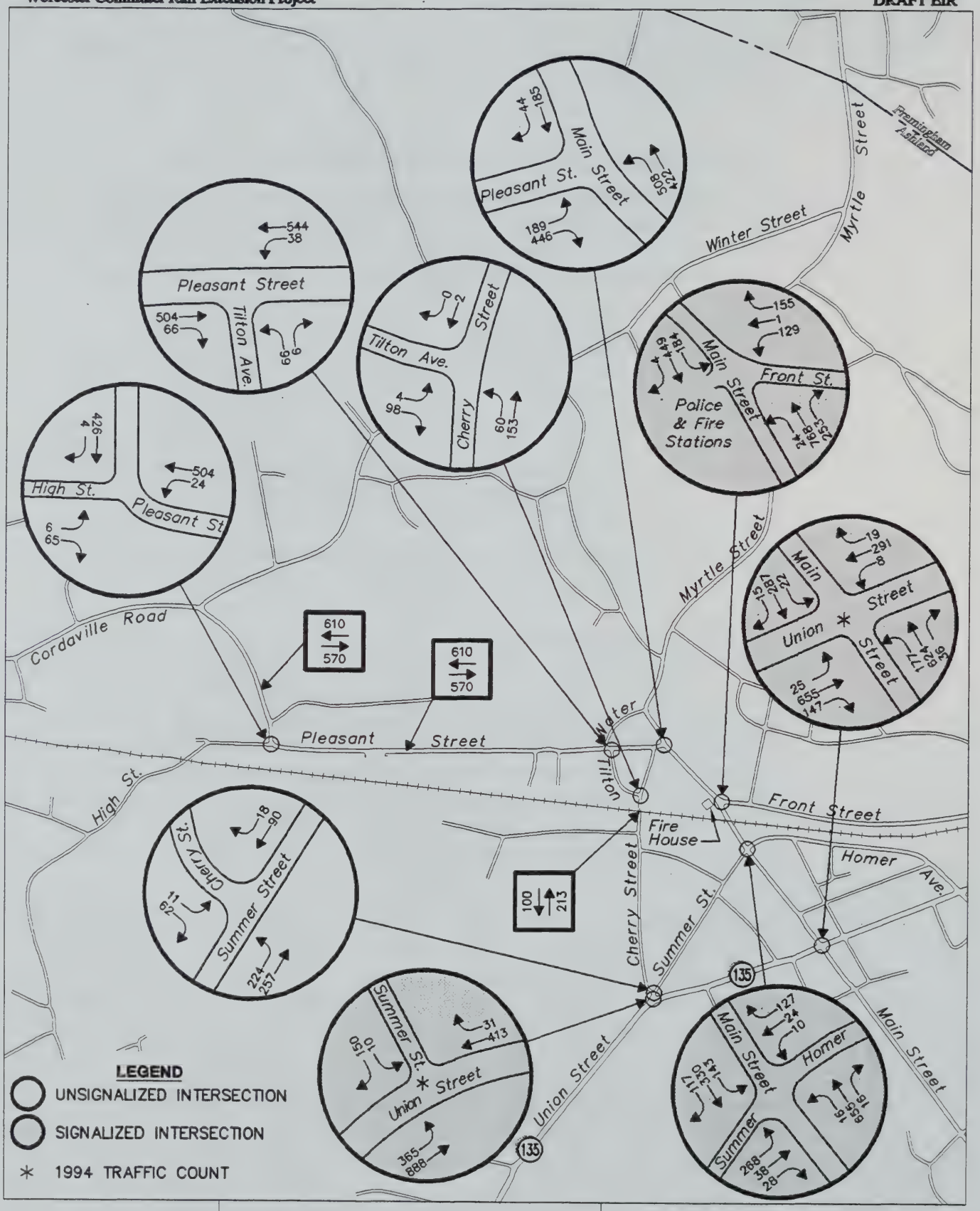
To determine the year 2001 "No Build" traffic volumes, the traffic volumes under the 1996 "No Build" conditions were adjusted based on anticipated growth in population and employment throughout the region. A growth rate of 1.5 percent per year was applied to the 1996 "No Build" traffic volumes. At this time, no significant developments are planned proximate to the study area. Figures 1.9-20 and 1.9-21 show the projected 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. roadway peak hour. Figures 1.9-22 and 1.9-23 show the projected year 2001 "No Build" traffic volumes within the study area for the A.M. and P.M. peak generator hours.

Year 2001 Trip Generation/Parking

Minor shifting is expected to occur in the town of origin of the patrons utilizing the proposed Ashland Station as presented in the 1996 conditions. The Massachusetts Central Transportation Planning Staff (CTPS) performed an analysis of projected ridership on the proposed commuter rail extension in the year 2001. CTPS projected that a total of 2,300 persons are expected to utilize the railroad for daily round trip commuting into Boston. The proposed Ashland station is projected to attract 837 of these commuters. Twenty of these patrons would walk to the station, and 65 would be dropped off. Based upon an average automobile occupancy rate of 1.12, the 752 remaining patrons would result in a parking demand of 671 spaces.

These patrons are projected to reside in the Towns of Ashland, Holliston, Hopkinton, Marlborough, Southborough, Upton, and Westborough. Based on the station's proposed location, all 20 of the patrons who walk to the station will originate in the Town of Ashland. The number of peak period commuting patrons originating from each Town are shown in Table 1.9-22.

Six percent of the total ridership is expected to occur outside of the peak A.M. and P.M. commuting periods, thus the 837 daily ridership was reduced to 788 riders during the peak commuting hours.



LEGEND

UNSIGNALIZED INTERSECTION

SIGNALIZED INTERSECTION

* 1994 TRAFFIC COUNT

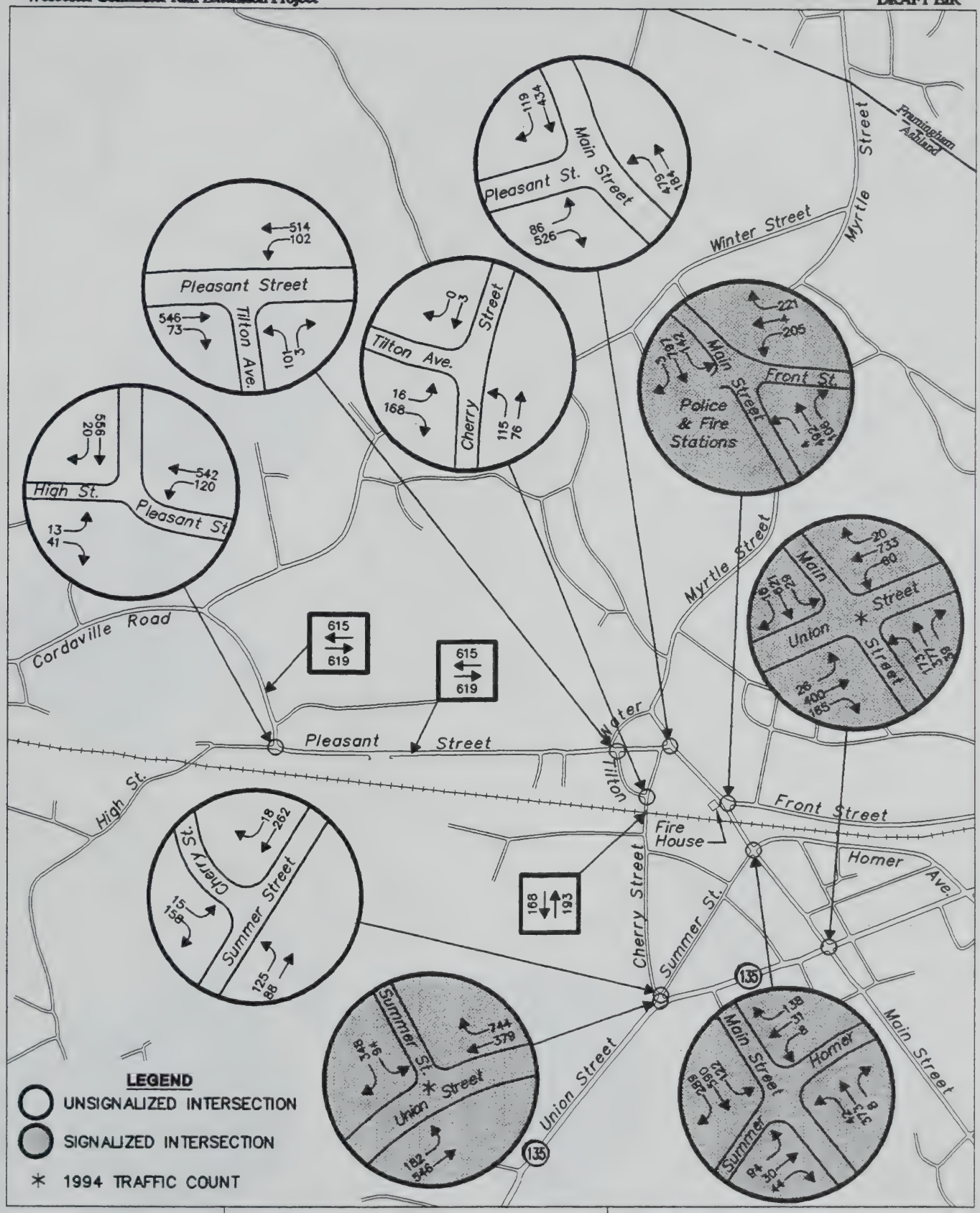
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-20

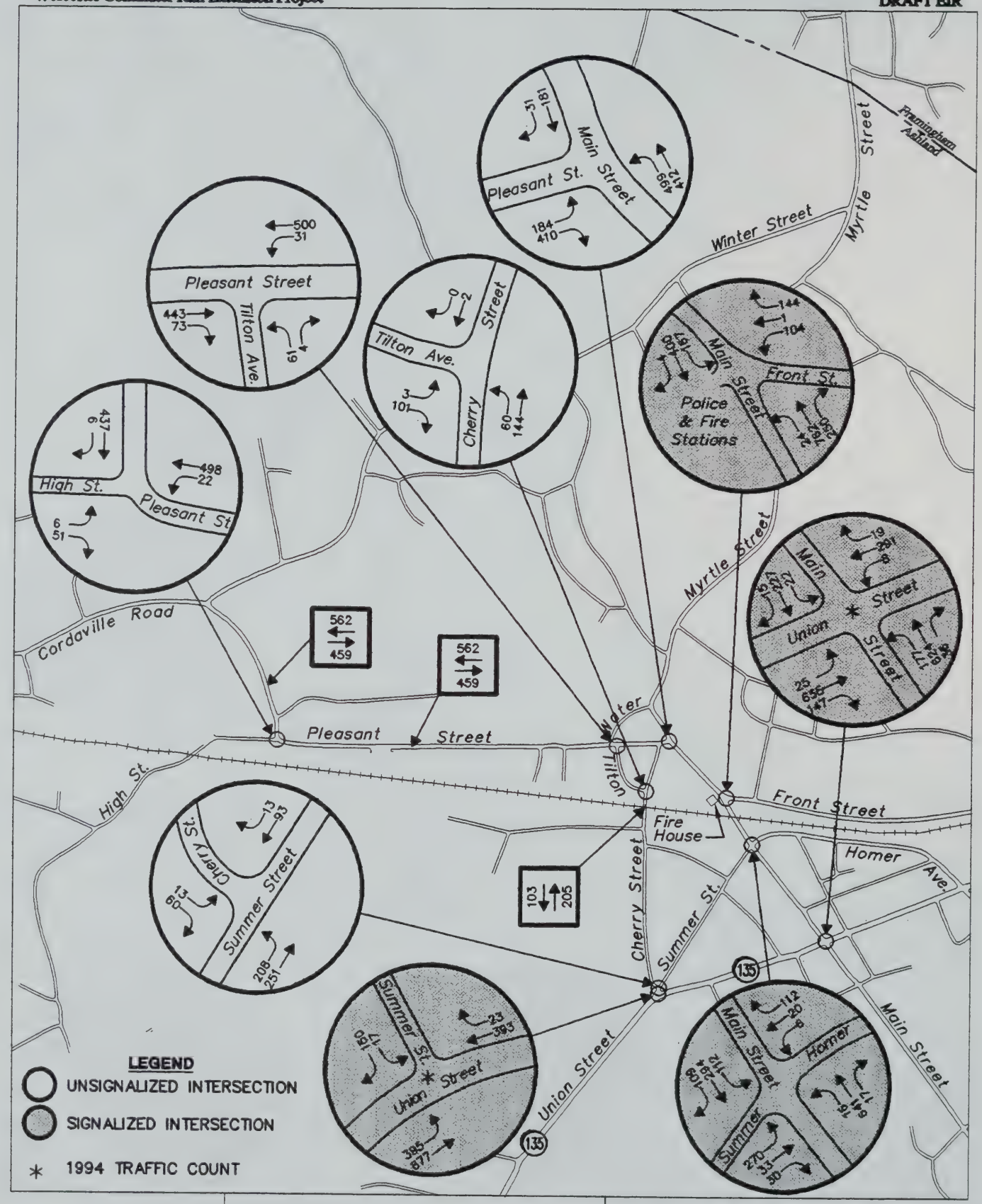


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
2001 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-21

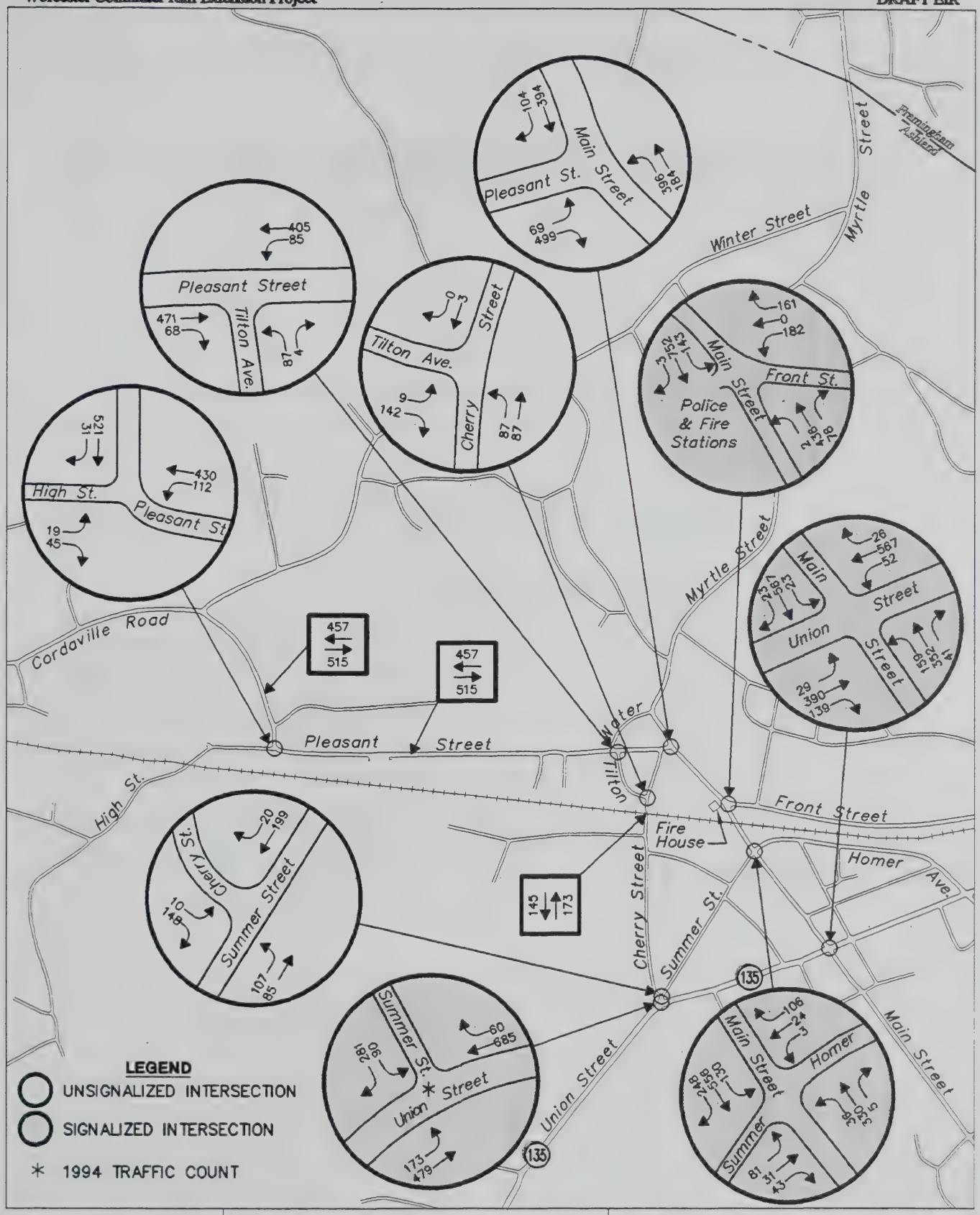


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
2001 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-22



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
2001 NO BUILD
ASHLAND STATION-WEST

FIGURE 1.9-23

Table 1.9-22 Projected Patrons of Ashland Station - Year 2001

Town	Riders*
Ashland	393**
Holliston	281
Hopkinton	50
Marlborough	24
Southborough	29
Upton	7
Westborough	4
Total	**788**

* *Adjusted for Peak Period Demand*
** *Includes 19 walk trips from Ashland*

Year 2001 Trip Distribution and Assignment

Not all of the projected ridership will arrive at the station at the same time, of even during the same peak hour. Ridership on each train will vary depending on the desired arrival time in Boston. Trains which arrive in Boston 15 to 20 minutes before the start of the business day will be more in demand than trains which arrive either much earlier of later. Similar trends are experienced during the P.M. peak return trip period. Trains that depart Boston 15 to 20 minutes after the close of business are in greater demand the those that depart at other times.

The distribution of ridership per train is the same as under the 1996 conditions. Table 1.9-23 lists the typical distribution of ridership based on arrival/departure time in Boston.

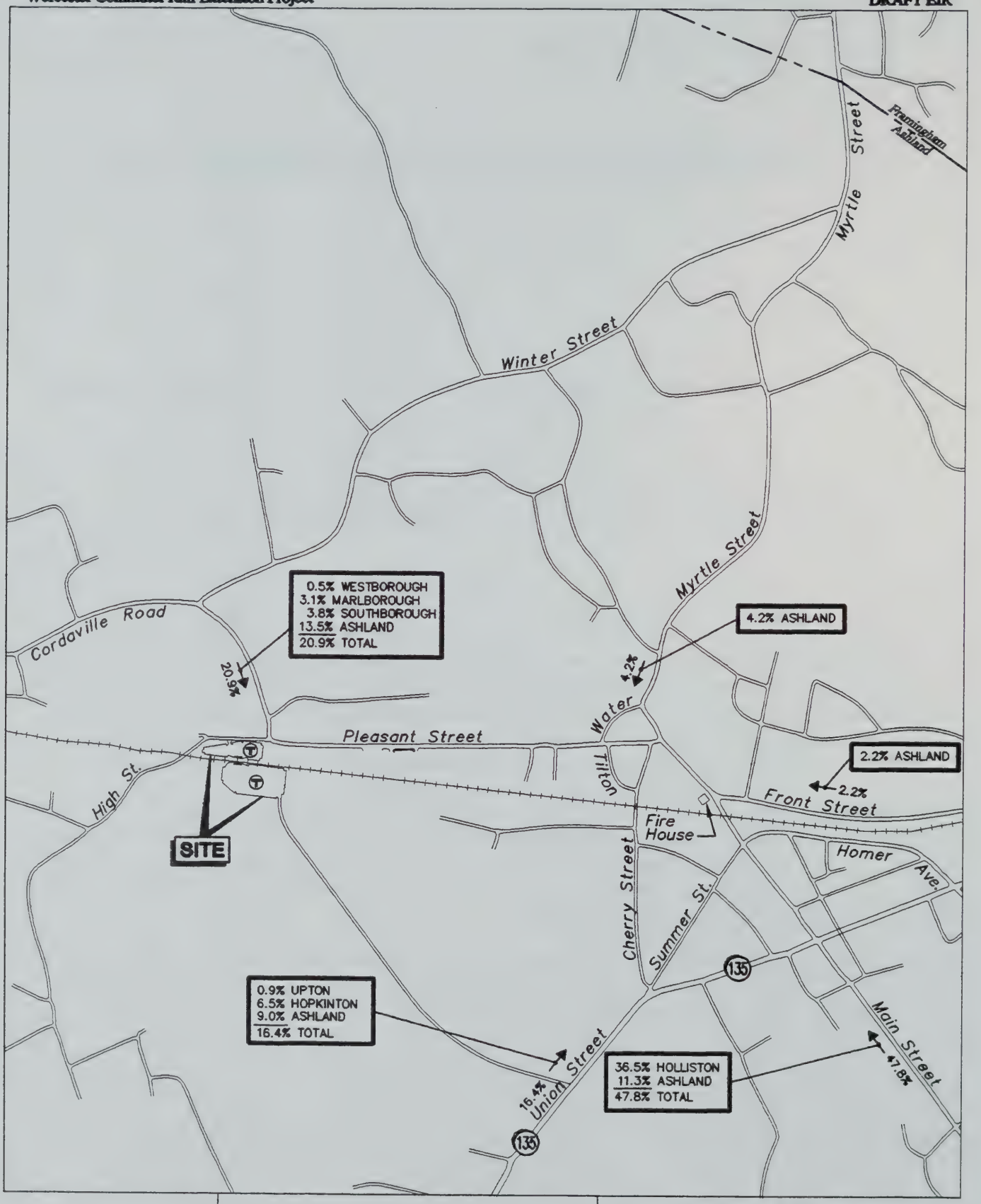
Table 1.9-23 MBTA Ridership Distribution

Inbound Train	Patrons
502A	154
504A	256
506A	256
510	122
Total	**788**
Outbound Train	**Patrons**
515A	110
519A	183
521A	182
523A	274
523	39
Total	**788**

Once the projected generated vehicle trips were distributed over time, the resulting peak hour totals were assigned to the study area roadway system. Patrons who reside in Ashland would utilize a variety of travel routes, depending on the location of their residence. Due to the minor shifts in town of origin of the patrons addressed previously, the percentage of site generated traffic on the study area roadways is slightly different than under the 1996 conditions.

Riders originating in towns outside that in which the station is located were assigned to major roadways. Patrons from Marlborough, Southborough, and Westborough would access the station via Cordaville Road. Patrons from Holliston, Hopkinton, and Upton would access the station via Union Street.

Actual routing was estimated based on shortest travel time and distance from population centers. Figure 1.9-24 shows the percentage of station related traffic utilizing the study area roadways.



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

Distribution of Commuter Rail Station Traffic
2001 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-24

Year 2001 "Build" Traffic Volumes

Traffic volumes under the year 2001 "Build" conditions consist of two primary elements:

- The projected year 1996 "No Build" traffic volumes.
- Traffic specifically diverted to the proposed Ashland rail station.

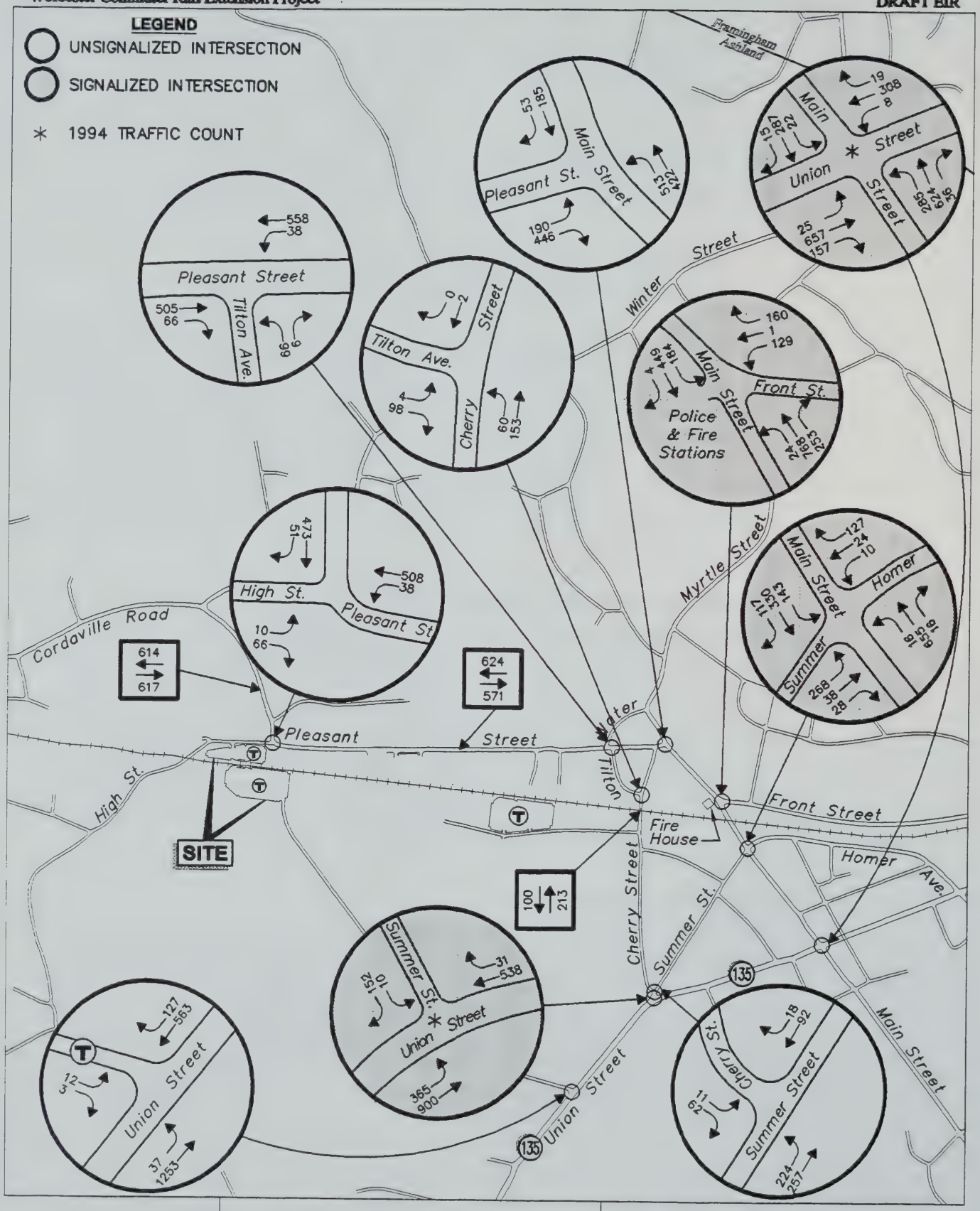
A portion of the traffic volumes heading to the proposed station would be diverted from existing travel routes through Ashland Center, which includes Pleasant Street. The existing vehicle trips would not be generated as completely new trips. The vehicles currently by-passing the site were assigned to the roadway network as if they were new trips. No attempt was made to account for the reduction in volume on specific roadways including Pleasant Street. This results in a "worst case" analysis. Figures 1.9-25 and 1.9-26 show the A.M. and P.M. peak roadway hour traffic volumes respectively. Figures 1.9-27 and 1.9-28 show the A.M. and P.M. peak generator hour volumes.

Year 2001 Peak Hour Level of Service

The same study area elements that were analyzed under the 1992 Existing and 1996 "No Build" conditions were analyzed under the 2001 "No Build" and "Build" conditions. The analysis was performed using the "all else being equal" assumption. The traffic volumes are the only parameter in the analysis that changes from the existing conditions. Roadway geometrics remain unchanged. Signal timings for the 2001 "No Build" condition were not changed from the existing conditions. For the 2001 "Build" condition, signal timings were optimized. Normal maintenance of traffic signals includes the recounting and retiming of traffic signals to account for changes in travel patterns.

Signalized Intersections

The signalized intersections were analyzed using the same methodology as in the existing conditions. Table 1.9-24 lists the results of the signalized intersection analysis for the A.M. and P.M. peak roadway traffic hours under the 2001 "No Build" and "Build" conditions. Under the 2001 "No Build" conditions, the Main Street/Front Street intersection would operate at level of service rating of "E" in the A.M. and P.M. peak hours. The "E" overall LOS rating is due to the northbound Main Street approach in the A.M. peak hour and the southbound Main Street approach in the P.M. peak hours having a LOS rating of "F".



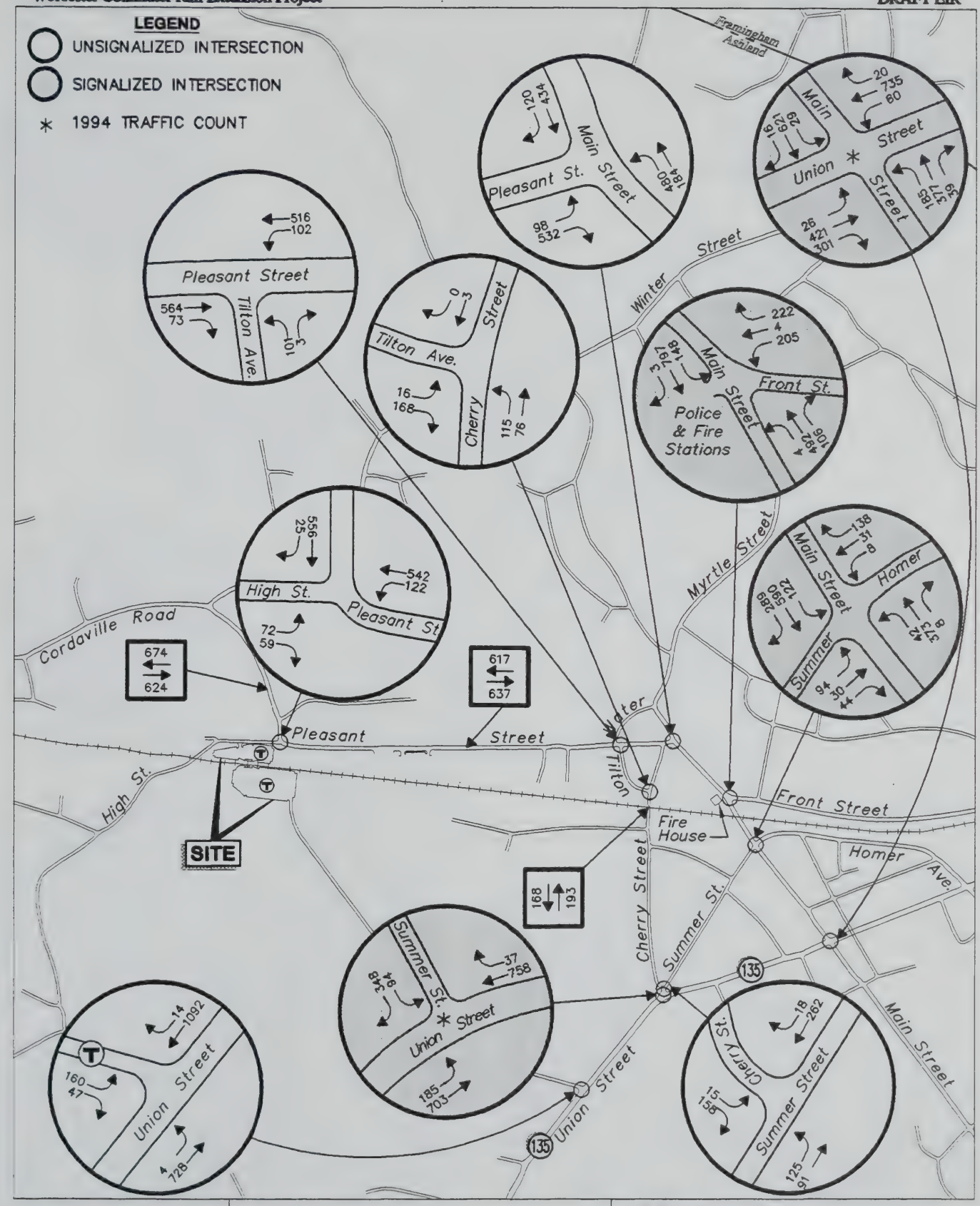
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

A.M. Peak Hour
7:30 - 8:30 A.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-25



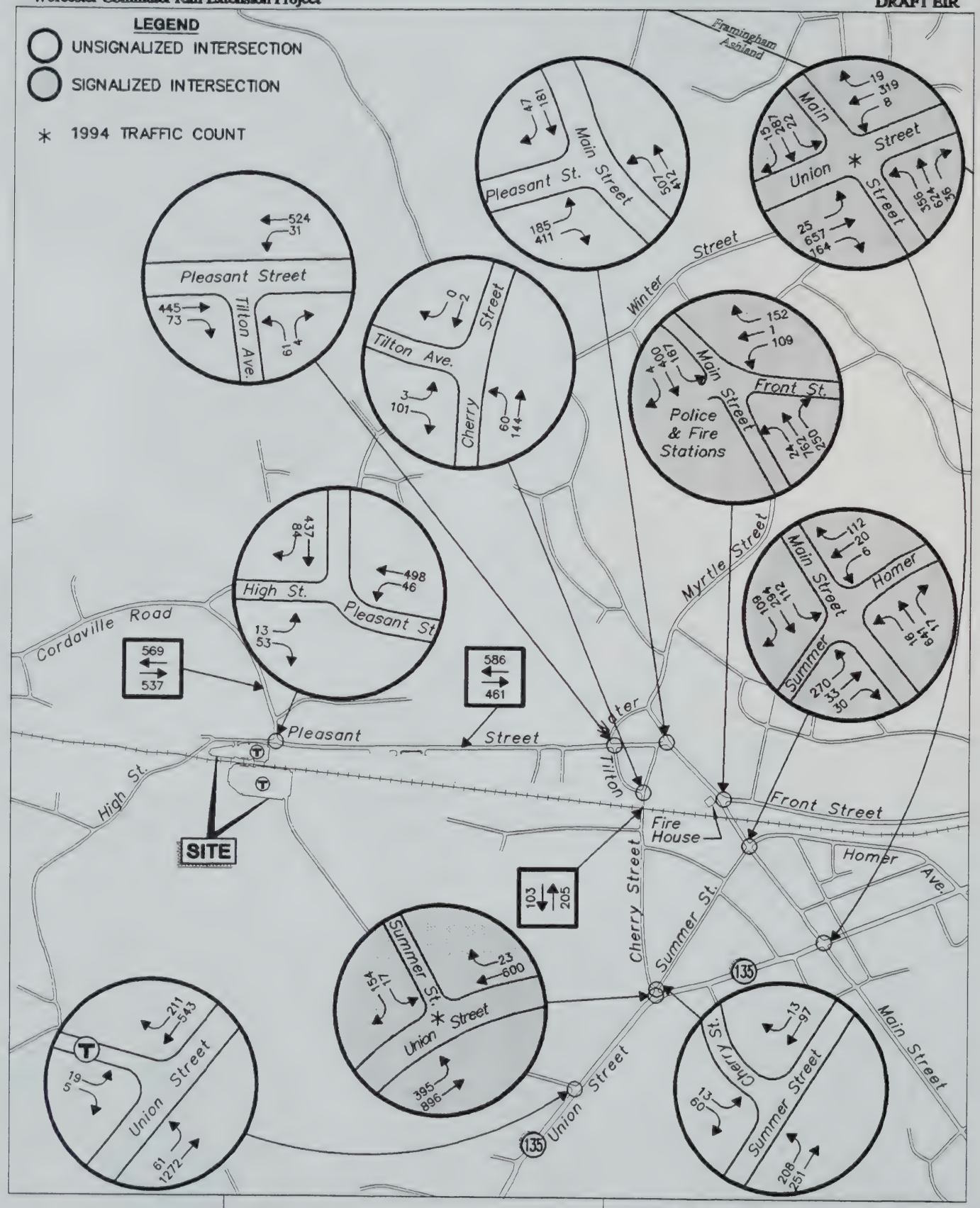
Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Hour
5:00 - 6:00 P.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-26

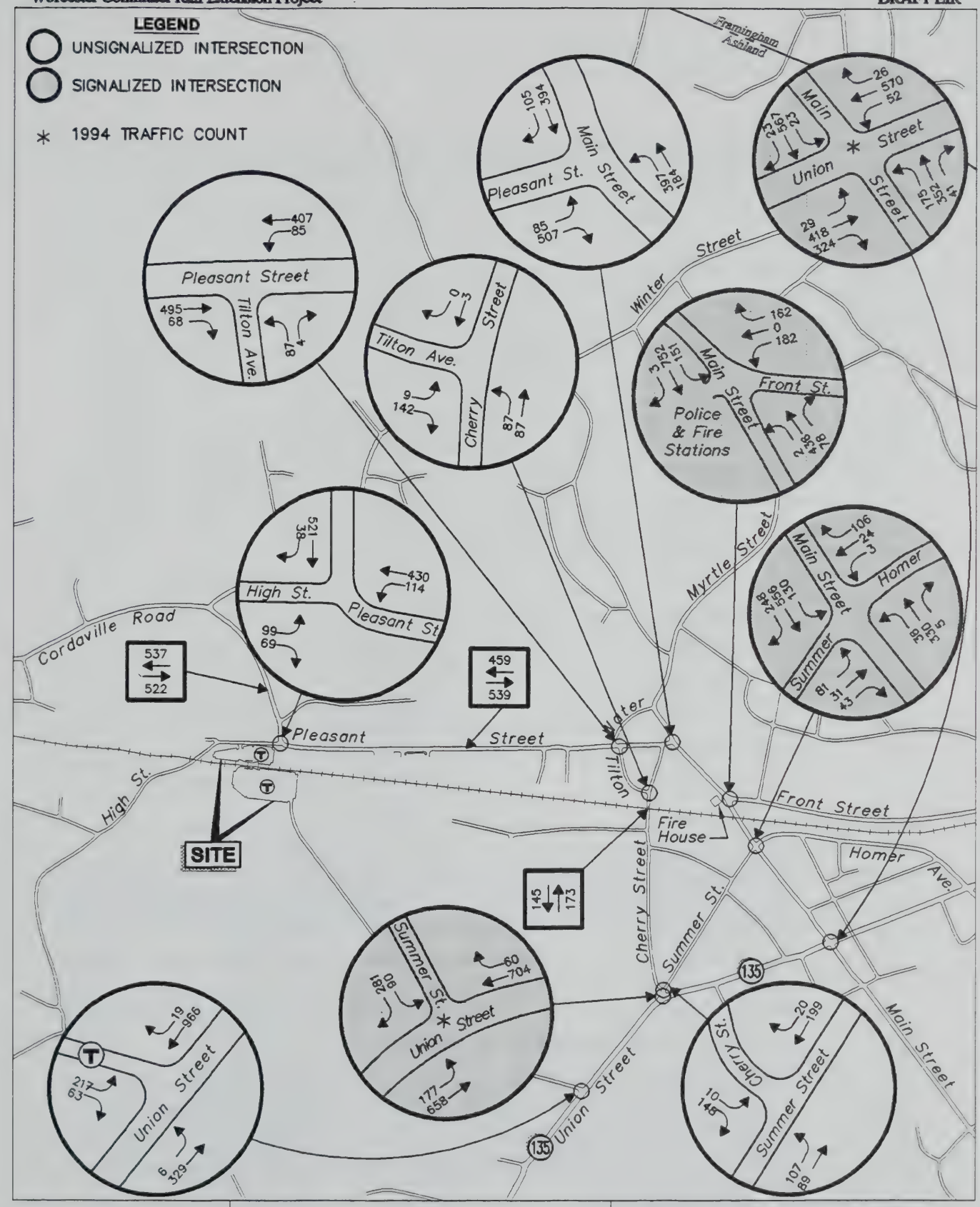


Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±
0 1250

A.M. Peak Generator Hour
7:15 - 8:15 A.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-27



Massachusetts Bay Transportation Authority

Approx. Scale: 1" = 1250'±

0 1250

P.M. Peak Generator Hour
5:30 - 6:30 P.M.
2001 BUILD ALL STATIONS
ASHLAND STATION-WEST

FIGURE 1.9-28

Table 1.9-24 2001 Peak Hour Signalized Intersection Levels of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	E(46.5)	E(43.3)	B(12.0)	D(30.7)
Westbound	C(23.5)	D(25.9)	D(38.9)	F(75.5)
Northbound	F(74.2)	C(17.4)	B(10.1)	B(5.2)
Southbound	B(11.9)	F(65.3)	A(2.9)	D(28.5)
Main with Summer	F*	C(19.9)	F*	B(9.4)
Eastbound	F(95.8)	C(19.4)	F*	D(29.1)
Westbound	C(17.3)	C(17.1)	C(21.9)	C(16.8)
Northbound	C(16.7)	B(9.0)	C(20.6)	A(3.2)
Southbound	F*	C(25.0)	F*	B(7.3)
Main with Union	F*	E(45.6)	E(50.7)	F*
Eastbound	F*	D(25.0)	F(60.3)	F*
Westbound	B(8.2)	F(93.9)	B(9.0)	F*
Northbound	C(22.6)	D(26.9)	F(70.4)	F*
Southbound	B(7.2)	C(22.5)	B(14.5)	C(23.1)
Union with Summer	F*	F*	D(34.6)	F*
Eastbound	F*	B(14.8)	C(24.5)	F*
Westbound	F(101)	F*	E(42.2)	F*
Southbound	B(14.6)	F(99.2)	F(84.8)	F*

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the 2001 "Build" conditions with the retiming of the traffic signals, the Main Street/Front Street intersection would operate at acceptable LOS ratings during both the A.M. and P.M. peak hours. The westbound approach of Front Street would operate at a LOS "F" during the P.M. peak hour.

Under the 2001 "No Build" conditions, the Main Street/Summer Street intersection would operate at LOS "F*" during the A.M. peak hour, with the southbound and eastbound approaches operating at a LOS rating of "F*" and "F". During the P.M. peak hour the overall intersection and all the approaches will be operating an acceptable LOS ratings.

Under the 2001 "Build" conditions with the retiming of the traffic signals, the Main Street/Summer Street intersection would operate at an overall LOS rating of "F*"

during the A.M. peak hour. This rating is due to both the eastbound Summer Street approach and southbound Main Street approach having LOS ratings of "F*". During the P.M. peak hour the overall LOS rating and the LOS rating for all the approaches will be acceptable.

Under the 2001 "No Build" conditions, the Main Street/Union Street intersection would operate and the overall LOS rating of "F*" in the A.M. peak hour and "E" in the P.M. peak hour. The A.M. overall "F*" rating is due to the eastbound Union Street approaches "F*" LOS rating. The P.M. overall "E" is due to the westbound Union Street approaches LOS rating of "F".

Under the 2001 "Build" conditions with the signal timings optimized, the Main Street/Union Street overall LOS ratings will be "E" in the A.M. peak hour and "F*" in the P.M. peak hour. The A.M. peak hour overall LOS rating of "E" is due to the eastbound Union Street approach and the northbound Main Street approach having a LOS rating of "F". The P.M. peak hour overall LOS rating of "F*" is due to the eastbound and westbound Union Street and the northbound Main Street approach having "F*" LOS ratings.

Under the 2001 "No Build" conditions, the Union Street/Summer Street intersection would operate at the overall LOS rating of "F*" in both the A.M. and P.M. peak hours. In the A.M. peak hour the overall "F*" LOS rating is caused by the eastbound Union Street approach LOS rating of "F*" and the westbound Union Street approach LOS rating of "F". In the P.M. peak hour the overall "F*" LOS rating is due to the westbound Union Street approach LOS rating of "F*" and the southbound Summer Street approach LOS rating of "F".

Under the 2001 "Build" conditions with the retiming of the traffic signals the Union Street/Summer Street intersection will operate at the overall LOS rating of "D" in the A.M. peak hour and the overall LOS rating of "F*" in the P.M. peak hour. During the A.M. peak hour the westbound Union Street approach will see a LOS rating of "E" and the southbound Summer Street approach will see a LOS rating of "F". During the P.M. peak hour all the approaches will see a LOS rating of "F*".

Unsignalized Intersections

The unsignalized intersections were analyzed using the same methodology as with the existing condition analysis. Results of the A.M. and P.M. peak roadway hour analysis are listed in Table 1.9-25. Under the 2001 "No Build" conditions, the intersection movements would generally operate at acceptable levels of service. The northbound left and right turn movements from Tilton Avenue to Pleasant Street would operate at a LOS rating of "E" during the A.M. peak hour and "F" during the P.M. peak hour. The eastbound left turn movement from Pleasant Street onto Main Street would operate at a LOS rating of "F" during both the A.M. and P.M. peak

hours and the eastbound right turn movement will operate at a LOS rating of "E" during the P.M. peak hour.

Under the 2001 "Build" conditions, the analyzed intersections would for the most part operate at acceptable levels of service. The northbound left and right turns from Tilton Street to Pleasant Street would operate at a LOS ratings "E" and "F" during the A.M. and P.M. roadway peak hours, respectively. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" during both the A.M. and P.M. peak hours and the eastbound right turn would operate at a LOS "E" during the P.M. peak hour. Traffic turning from High Street to Pleasant Street will operate at LOS "F" in the P.M. peak hour.

In addition to the intersections analyzed under the 1992 Existing and 2001 "No Build" scenarios, the intersection of the proposed station access driveway to Union Street were analyzed under the 2001 "Build" conditions. During the A.M. and P.M. peak hours the site's driveway traffic turning left to eastbound Union Street will have a LOS rating of "E"/"F".

Table 1.9-25 2001 Peak Hour Unsignalized Intersection Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(608)	A(404)	A(323)	B(394)
LT and RT from High	B(314)	D(116)	C(227)	F(-33)
Pleasant with Tilton				
LT from WB Pleasant	A(567)	A(469)	A(567)	A(456)
LT and RT from Tilton	E(66)	F(-2)	E(63)	E(-6)
Main with Pleasant				
LT from NB Main	A(443)	C(243)	A(438)	C(242)
LT from Pleasant	F(-115)	F(-31)	F(-118)	F(-43)
RT from Pleasant	B(383)	E(81)	B(383)	E(75)
Cherry with Tilton				
LT from NB Cherry	A(1117)	A(1062)	A(1117)	A(1062)
LT and RT from Tilton	A(942)	A(832)	A(942)	A(832)
Summer with Cherry				
LT from EB Summer	A(831)	A(757)	A(829)	A(757)
LT and RT from SB Cherry	A(680)	A(557)	A(678)	A(556)
THRU and RT from WB Summer	A(416)	B(300)	A(414)	C(229)
Union with Site's South DW				
LT from EB Union	-	-	A(487)	B(303)
LT from Parking Lot	-	-	E(13)	F(-128)
RT from Parking Lot	-	-	A(449)	D(180)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.9-26 lists the results of this analysis for the A.M. and P.M. peak roadway hours.

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station, and Pleasant Street east of the site are listed as operating at a LOS "E" under the "No Build" and "Build" conditions, there is sufficient reserve capacity to accommodate over 900 additional vehicles before reaching capacity.

Table 1.9-26 2001 "Build" Peak Hour Road Segment Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1072)	E(1079)	E(1059)	E(983)
Pleasant Street East of Site	E(1203)	E(1215)	E(1200)	E(1179)
Cherry Street at Railroad Grade Crossing	C(1689)	C(1780)	D(1556)	D(1616)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. As seen in the tables, the stopping of traffic for train crossings does not have a significant impact on the flow of traffic along Cherry Street.

Year 2001 Peak Generator Hour Level of Service

Signalized Intersections

Analysis was also performed for the peak site generation hours. The results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.9-27 for the 2001 "No Build" and "Build" conditions.

As shown in the table, under the 2001 "No Build" conditions, the Front Street/Main Street intersection would operate at a LOS "E" during the A.M. peak hour, with the northbound approach operating at a LOS "F". During the P.M. peak hour the southbound Main Street approach will operate at a LOS rating of "E".

Table 1.9-27 2001 Peak Generator Hour Signalized Intersection Levels of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Main with Front	E(47.8)	D(36.8)	B(12.0)	C(24.9)
Westbound	C(23.0)	D(26.0)	D(35.0)	F(61.9)
Northbound	F(75.1)	C(15.2)	B(11.5)	A(5.0)
Southbound	B(9.8)	E(53.1)	A(2.4)	C(21.4)
Main with Summer	F*	D(28.9)	F*	B(9.6)
Eastbound	F(118)	C(18.9)	F*	D(30.7)
Westbound	C(16.7)	C(16.8)	C(20.5)	C(16.4)
Northbound	C(16.9)	B(8.7)	C(22.9)	A(2.7)
Southbound	F*	D(39.6)	F*	B(8.1)
Main with Union	F*	D(29.9)	F(64.2)	F*
Eastbound	F*	C(22.7)	E(106)	F*
Westbound	B(8.2)	E(54.3)	B(13.2)	F*
Northbound	C(22.6)	C(16.9)	F(63.8)	F*
Southbound	B(7.4)	C(19.6)	C(15.0)	D(29.1)
Union with Summer	F*	F*	E(54.4)	F*
Eastbound	F*	B(13.8)	D(36.0)	F*
Westbound	F(97.2)	F*	E(70.9)	F*
Southbound	B(14.5)	F(61.3)	F(128)	F*

LOS (Average Vehicle Stopped Delay in Seconds)

* *Calculation of average vehicle stopped delay is not valid when volumes exceed capacity by 20% or more*

Under the "Build" condition with the signal retimed the A.M. peak generator hour can see all the approaches operating at acceptable LOS ratings with only the westbound Front Street approach seeing the LOS rating of "F" during the P.M. peak hours.

Under the "No Build" condition the intersection of Main Street/Summer Street will see an overall LOS rating "F*" during the A.M. peak generator hour with an acceptable overall LOS rating during the P.M. peak generator hour. The "F*" rating on the A.M. peak generator hour is caused by the southbound Main Street approaches LOS rating of "F*" and the eastbound Summer Street approaches LOS rating of "F".

Under the "Build" condition with the signal retimed the overall LOS rating will be "F*" for the A.M. peak generator hour. This is due to the eastbound Summer Street and southbound Main Street LOS rating being "F*".

Under the "No Build" condition the intersection of Main Street/Union Street will have an overall LOS rating of "F*" in the A.M. peak generator hour. The "F*" rating is due to the eastbound Union Street approach having a LOS rating of "F*" During the P.M. peak generator hour only the westbound Union Street approach will see LOS rating of "E".

Under the "Build" condition with signal retiming the overall LOS rating will be "F" and "F*" in the A.M. and P.M. peak generator hours. The A.M. peak generator hour LOS rating of "F" is due to the eastbound and northbound approach is having LOS ratings of "F". The P.M. peak generator hour LOS rating of "F*" is due to the eastbound, westbound, and northbound approach is having a LOS rating of "F*".

Under the "No Build" condition the intersection of Union Street/Summer Street will have an overall LOS rating of "F*" in both the A.M. and P.M. peak generator hours. The A.M. peak generator LOS rating is due to the eastbound Union Street approach having of LOS rating of "F*" and the westbound Union Street approach having a LOS rating of "F". The P.M. peak generator hours LOS rating is due to the westbound Union Street approach LOS rating being "F*" and the southbound Summer Street approach LOS rating being "F".

Under the "Build" condition with signal retimings the A.M. peak generator hour overall LOS rating will be "E" due to the westbound and southbound approaches having a LOS rating of "F". The P.M. peak generator hour overall LOS rating will be "F*" along with all of the approaches.

As with the previous "No Build" and "Build" condition analysis, the approach capacities for analyzing the intersections of Main Street with Front Street and Main Street with Summer Street and Homer Avenue were modified to account for the gate closings of the at-grade railroad crossing separating these intersections.

Unsignalized Intersections

Results of the A.M. and P.M. peak generator hour analysis are listed in Table 1.9-28. Under the 2001 "No Build" conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from Tilton Avenue to Pleasant Street would operate at a LOS "E" during the P.M. hour. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" and a LOS "E" during the A.M. and P.M. peak generator hours respectively.

Under the 2001 "Build" conditions, the analyzed intersections would generally operate at acceptable levels of service. The northbound left and right turns from

Tilton Avenue to Pleasant Street would operate at a LOS "E" during both the A.M. and P.M. peak generator hours. The eastbound left turn from Pleasant Street to Main Street would operate at a LOS "F" and a LOS "E" during both the A.M. and P.M. peak hours. High Street traffic will operate at LOS "F" in the P.M. peak hour.

The intersection of the site driveway with Union Street was also analyzed. The left turn movement from the driveway to eastbound Union Street will have an A.M. and P.M. peak generator hour LOS ratings of "E" and "F", respectively.

Table 1.9-28 2001 Peak Generator Hour Unsignalized Intersection Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Pleasant with High				
LT from WB Pleasant	A(600)	A(428)	A(541)	A(423)
LT and RT from High	B(306)	D(129)	C(259)	D(106)
Pleasant with Tilton				
LT from WB Pleasant	A(615)	A(543)	A(613)	A(526)
LT and RT from Tilton	D(101)	E(66)	E(94)	E(59)
Main with Pleasant				
LT from NB Main	A(456)	B(365)	A(448)	B(364)
LT from Pleasant	F(-105)	E(28)	F(-110)	E(11)
RT from Pleasant	A(420)	D(140)	B(419)	D(132)
Cherry with Tilton				
LT from NB Cherry	A(1117)	A(1090)	A(1117)	A(1090)
LT and RT from Tilton	A(947)	A(886)	A(947)	A(886)
Summer with Cherry				
LT from EB Summer	A(850)	A(835)	A(845)	A(835)
LT and RT from SB Cherry	A(665)	A(649)	A(661)	A(649)
THRU and RT from WB Summer	A(425)	B(398)	A(420)	B(396)
Union with Site's South DW				
LT from EB Union	-	-	A(423)	B(355)
LT from Parking Lot	-	-	E(2)	F(-124)
RT from Parking Lot	-	-	A(433)	C(211)

LOS (Reserve Capacity-Vehicles)

Roadway Segments

The roadway segments discussed in the existing conditions were also analyzed for level of service under the 2001 "No Build" and "Build" conditions. Table 1.9-29 lists the results of this analysis for the A.M. and P.M. peak generator hours.

As shown in the table, all of the roadway segments analyzed would operate at acceptable levels of service. Although the section of Cordaville Road west of the proposed station is listed as operating at a LOS "E" under the "Build" and "No Build" conditions, there is sufficient reserve capacity to accommodate over 1,100 additional vehicles before reaching capacity.

Table 1.9-29 2001 "Build" Peak Generator Hour Road Segment Level of Service

Ashland-West	No Build		Build	
	A.M.	P.M.	A.M.	P.M.
Cordaville Road West of Site	E(1151)	E(1281)	E(1178)	E(1251)
Pleasant Street East of Site	D(1269)	D(1415)	D(1288)	D(1394)
Cherry Street at Railroad Grade Crossing	C(1649)	C(1810)	D(1487)	D(1688)

The number in parenthesis is called the reserve capacity of the road. Reserve capacity is the additional traffic volume which the road can accommodate before reaching maximum capacity, which is LOS "F".

The Cherry Street roadway segment was selected for analysis due to the existing at-grade railroad crossing. As seen in the table, the stopping of traffic for train crossings does not have a significant impact on the flow of traffic along Cherry Street.

Year 2001 "Ten Percent of Traffic" Analysis

Massachusetts Environmental Policy Act guidelines require the analysis of any intersection or roadway segment where the projected site generated traffic exceeds ten percent of the projected "Build" traffic volumes. Table 1.9-30 lists the site generated traffic as a percentage of the total traffic within the study area during the A.M. and P.M. roadway and peak generator hours.

As shown in the table, none of the intersections meet the 10 percent threshold requirements, though the Union Street with the south driveway intersection will round off to ten percent.

As shown in the table none of the road segments meet the 10 percent threshold requirements.

Table 1.9-30 2001 "Build" Condition - 10 % Analysis

Intersection	Peak Hours	
	A.M.	P.M.
Pleasant with High	5.0%	5.0%
Pleasant and Tilton	1.2%	1.5%
Main and Pleasant	0.8%	1.1%
Main and Front	0.3%	0.4%
Main and Summer	0.0%	0.0%
Main and Union	5.9%	6.4%
Cherry with Tilton	0.0%	0.0%
Summer with Cherry	0.3%	0.5%
Union with Summer	7.5%	8.9%
Union with Site's South	9.9%	9.6%
Roadway Segment		
Cordaville Rd. West	4.3%	5.2%
Pleasant St. East	1.3%	1.6%
Cherry St. at Railroad	0.0%	0.0%

Site generated traffic as a percentage of total traffic

Summary of Findings

The basic findings of the traffic analysis were that most of the streets and intersections studied in Ashland are currently operating well. The addition of the proposed commuter rail station would attract a projected ridership of 837 patrons by the year 2001, while seriously impacting only two of the Town's intersections. These two signalized intersections lie south of the rail tracks on Union Street. The Main Street/Union Street and Union Street/Summer Street intersections would be burdened by the additional traffic during A.M. and P.M. peak hours. It should be noted that even without the proposed commuter rail station in place, these two intersections are projected to have serious congestion problems due to normal growth, particularly during morning peak hours. Optimization of the signal timings at these intersections

may realize an improvement for their level of service ratings. High Street at its intersection with Pleasant Street will experience some impacts due to traffic exiting the station. It should also be noted that construction of the commuter rail facility will have a positive impact on other routes throughout Ashland, particularly Route 135, Route 126, Main Street through the center of town, and the Massachusetts Turnpike, by removing a portion of their peak hour traffic.